GLOBAL CLIMATE CHANGE

HEARING

BEFORE THE

SUBCOMMITTEE ON OCEANOGRAPHY
AND THE GREAT LAKES

OF THE

COMMITTEE ON
MERCHANT MARINE AND FISHERIES
HOUSE OF REPRESENTATIVES

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

H.R. 980

A BILL TO PROVIDE FOR DEVELOPMENT OF A NATIONAL GLOBAL CHANGE RESEARCH PLAN; TO ESTABLISH THE COUNCIL ON GLOBAL ENVIRONMENTAL POLICY; AND TO AMEND THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

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CONTENTS

Page
Hearing held May 4, 1989 1
Text of H.R. 980 37

Statement of:

Alter, Harvey, manager, Resources Policy Department, U.S. Chamber of Commerce (prepared statement) 89
Davis, Hon. Robert W., a U.S. Representative from Michigan 3
Evans, William E., Under Secretary for Oceans and Atmosphere, NOAA, Department of Commerce (prepared statement) 139
Hertel, Hon. Dennis M., a U.S. Representative from Michigan, and Chairman, Subcommittee on Oceanography and the Great Lakes 1
Kelly, Earl, Director of Government Affairs, American Wind Energy Association (prepared statement) 156
Moomaw, Dr. William R., director, Climate, Energy, and Pollution Program, World Resources Institute 4
  Prepared statement 67
Moya, Susan C., manager, Energy and Natural Resources Policy, Resources Policy Department, U.S. Chamber of Commerce 13
  Prepared statement 78
Peck, Dr. Dallas L., director, United States Geological Survey, Department of the Interior 33
  Prepared statement 152
Saxton, Hon. Jim, a U.S. Representative from New Jersey 2
Schneider, Dr. Stephen H., National Center for Atmospheric Research 16
  Prepared statement 103
Shumway, Hon. Norman D., a U.S. Representative from California 2
Slocum, Robert W., Jr., executive vice president, North Carolina Forestry Association, Incorporated 11
  Prepared statement 74
Solow, Dr. Andrew, Marine Policy Center, Woods Hole Oceanographic Institute 23
  Prepared statement 125
Thomas, Dr. Alan R., acting assistant administrator, Oceanic and Atmospheric Research, NOAA, Department of Commerce 30

Additional material supplied:

Background Memorandum of May 2, 1989, to Members, Subcommittee on Oceanography and the Great Lakes 55
Department of Commerce: ....
  Departmental Explanation of the Variance on H.R. 980 (The Global Environment Research and Policy Act of 1989), and S. 169 (The National Global Change Research Act of 1989) 161
  Departmental Views on S. 169 (The National Global Change Research Act of 1989) 163
  Recommended Technical Amendments to S. 169 165
Neiderlehner, L., (Department of Defense): Response to Request for Views of Department of Defense on H.R. 980 53

GLOBAL CLIMATE CHANGE AND THE GLOBAL ENVIRONMENT RESEARCH POLICY ACT

THURSDAY, MAY 4, 1989

House of Representatives,
Subcommittee on Oceanography and Great Lakes,
Committee on Merchant Marine and Fisheries,
Washington, DC.

The Subcommittee met, pursuant to notice, at 11:06 a.m., in Room 1334, Longworth House Office Building, the Hon. Dennis M. Hertel (chairman of the subcommittee) presiding.

Members present: Representatives Hertel, Brennan, Lowey, Shumway, Saxton, Weldon, and Pallone.

Staff present: Dan Ashe, Brian O'Malley, Bill Ashworth, Joan Bondareff, Gwen Lockhart, Lisa Pittman, Larry Flick, Tom Kitsos, Edmund B. Welch, Lori Williams, Charly Moore, Judy Wells, and Lola Wesson.

Mr. **Hertel**. Good morning. I will call the meeting to order.

OPENING STATEMENT OF HON. DENNIS M. HERTEL, A U.S. REPRESENTATIVE FROM MICHIGAN, AND CHAIRMAN, SUBCOMMITTEE ON OCEANOGRAPHY AND THE GREAT LAKES

Mr. **Hertel**. The Subcommittee on Oceanography and the Great Lakes meets today on the topic of global change.

Since man first began to speak, the weather and its changes have been popular. The drought of last summer, and unusually intense hurricanes like Gilbert, have added greater urgency to formerly routine conversations. There exists a strong public sentiment that the weather is changing on a vast scale.

The reality of the public's perception is the question before us. Is our climate changing on a global scale? Is human activity causing the change? What should be done? How reliable is our data and what other information or technologies do we need to evaluate this situation?

I hope our witnesses will illuminate the realities we are facing with global warming and the greenhouse effect. Various accounts of these phenomenon range from apocalyptic to cautionary.

Our Subcommittee is in the process of educating ourselves. Of particular interest is the precise nature of the role of the oceans in global changes.

We are also very interested in our witnesses' opinions and advice on Chairman Jones' bill, H.R. 980, the Global Environment Research and Policy Act.

I now call on the Ranking Member of the Subcommittee. Mr. Shumway.

OPENING STATEMENT OF HON. NORMAN D. SHUMWAY, A U.S. REPRESENTATIVE FROM CALIFORNIA

Mr. **Shumway**. Thank you, Mr. Chairman. Today's hearing is a very important hearing, not just for this Subcommittee, but for the entire Congress, and, for that matter, the entire Nation, and even the world.

This is a matter of first impression for this Subcommittee, and I think it is very appropriate that we are getting into this issue today.

There is no doubt that the scientific community is only now beginning to understand the many facets of the global climate trends. We have had a great deal of talk in recent years about the "greenhouse effect," about the warming of the Earth at a very alarming rate, but the scientific reasons for some of those trends I think remain unclear.

There is one thing that we can be certain about, however, and that is the need to establish a sensible research policy, one that would methodically and thoroughly, and comprehensively, examine this entire subject.

And in connection with that, exploring the role of the oceans and global trends from the ocean point of view seems to be one of the real keys in beginning to understand the worldwide phenomenon.

So, your leadership, Mr. Chairman, in scheduling this hearing and moving forward in this area, I think is commendable, and I look forward to welcoming the witnesses and hearing their testimony as the hearing proceeds. Thank you.

Mr. **Hertel**. Mr. Saxton.

OPENING STATEMENT OF HON. JIM SAXTON, A U.S. REPRESENTATIVE FROM NEW JERSEY

Mr. **Saxton**. Thank you, Mr. Chairman. I would just like to say, and let me just join with Mr. Shumway, in associating myself with the remarks that he has made relative to this subject, and relative to the role that you are playing here in terms of getting us together to consider what I consider to be a very important bill.

I think public awareness is growing with regard to the importance of the subject that we are here to consider today. This morning, I happened to see a television program that had to do with this very subject, as it relates to the ocean, and they were pointing out examples of what it might mean in low-lying coastal areas, such as Florida, in terms of the environmental impact that it could have, and I remember the closing line was that perhaps those of us who are in these areas are looking at a situation where we are faced with a ocean flood, rising water, with no ark presently in sight.

And I hope that the public understands the importance of this issue. I hope that business and industry understands the importance of this issue, and I hope that other countries—China, for example, which is on the verge of refrigerating its country, so to speak—a billion people who are going to have new methods of refrigeration. I hope that as those refrigeration units are put into place in China, and around the world, that people will take into consideration the need to do that safely, and in a prudent manner.

And so today is perhaps one small step forward for us in terms of putting in place a procedure to understand the importance of this matter, and of all those things that contribute to it.

And again, Mr. Chairman, I want to commend you for calling this hearing this morning. Thank you very much.

Mr. HERTEL. Thank you, Mr. Saxton. Mr. Weldon, do you have an opening statement?

Mr. WELDON. No, Mr. Chairman.

Mr. SHUMWAY. Mr. Chairman, I have a statement by Congressman Davis. I would ask unanimous consent that it be included in the record.

Mr. HERTEL. So ordered.

[The statement of Mr. Davis follows:]

STATEMENT OF HON. ROBERT W. DAVIS, A U.S. REPRESENTATIVE FROM MICHIGAN

For the Great Lakes, global climate change can be both a boon and a bust. The University of Wisconsin Sea Grant Institute has predicted that the warming of the earth would lengthen the growing season of many Great Lakes fish species, allowing for some dramatic size increases. While this may please anglers, warmer Great Lakes water could also prompt excessive algae growth and block the transfer of oxygen-rich surface waters to the Lake bottoms. In addition, under many global warming scenarios, the Midwest becomes an arid place, increasing the demand on Great Lakes water for irrigation of the Great Plains, drinking water, and industrial use.

This demonstrates that the Great Lakes can play an important role in serving the scientific community as a perfect microcosm to study the effects of rising earth temperatures on coastal communities and habitat, the fishing and shipping industries, agricultural and forestry interests, hydropower and manufacturing.

While global warming is the new "hot" topic for the scientific community and the media, for once it appears that the Federal Government is planning ahead. We appear to be facing this issue in a responsible way, and have already organized both domestic and international resources to help identify, determine with the effects, and mitigate damages caused by increasing temperatures. We should build on these existing mechanisms to develop a coherent policy to face this change in our world. We should avoid the creation of too many advisors and study groups in favor of concentrating our efforts and funds in actual research into the causes and effects of global climate change, and in the development of ways to cope and avoid damage to our natural resources and our investments.

I look forward to hearing from our witnesses, and applaud Mr. Hertel for recognizing the function that the oceans will be playing in global climate change and the role that this Committee should have been playing in the global climate game all along.

Mr. HERTEL. Well, in the interest of time, we are going to move right ahead. As you see, as I speak, we are having our first vote on the budget, which will be happening intermittently today. So we might as well, instead of beginning and trying to rush the Doctor, wait until we come back. We will see you in a little bit. Thank you.

[Brief recess.]

Mr. HERTEL. I will reconvene the hearing now.

Our first witness will be Dr. William R. Moomaw, Director, Climate, Energy and Pollution Program, World Resources Institute.

STATEMENT OF DR. WILLIAM R. MOOMAW, DIRECTOR, CLIMATE, ENERGY AND POLLUTION PROGRAM, WORLD RESOURCES INSTITUTE

Dr. MOOMAW. I wish to thank the Chairman, Congressman Hertel, for the opportunity to testify before the Subcommittee on this central issue of global climate change.

I think two aspects of global climate change are striking to any observer. The first is the rapidity with which this problem is entering the public and political consciousness, as evidenced by the level of press coverage and congressional activity such as hearings of this kind, and the more than one dozen bills that have been introduced into the Congress.

Public awareness is often a function of the closeness of the consequences of a perceived problem, but what is remarkable is the desire of the public to address what all of us recognize as the most challenging environmental, economic and political issue we have ever faced, even though the serious consequences may not occur for decades to come.

The complexity of human-caused global change arises because of the intrinsic linkages that exist among the major factors that need to be considered. The so-called "greenhouse effect" that I will make most of my remarks about, is caused by the emission of carbon dioxide and other gases released from energy production, agriculture, and industrial processes.

The greenhouse effect and the emission of gases are also linked to a host of related critical problems including climate modification, sea level rise, deforestation, air pollution, acid rain, and stratospheric ozone depletion issues.

The greenhouse effect, were it to be discovered today, for the first time, instead of as it was, 160 years ago, would probably be called the "hot car effect." It is an experience we have all shared on a summer day in Washington when we leave the windows of our car closed, the sunlight has passed through the glass windows and the heat it produces has been trapped inside.

The atmosphere is able to behave in a similar way because of the presence of very small amounts of trace gases—carbon dioxide and water vapor being the principal two, that allow sunlight to reach the earth's surface, but trap the radiant heat as it is emitted from the warm earth to outer space. As we now know, there are a significant number of additional gases which are rapidly accumulating in the atmosphere which are turning what would otherwise be a benign greenhouse into what Norway's Prime Minister, Ms. Gro Harlen-Bruntland, describes as a "heat trap."

It would greatly simplify decision making if we could be certain that the enhanced greenhouse effect has arrived, so that we would know what we were responding to. Many believe that we need a climate analogue to the Antarctic ozone hole that would stimulate us into some action.

But there is disagreement within the scientific community, whether we have actually seen the greenhouse effect yet, and some of the other witnesses will probably be addressing that particular issue.

There is a dilemma, however, in waiting for conclusive proof in the face of such severe potential consequences. At a scientific meeting held in November of 1987 in Bellagio, Italy, it was suggested it might take 30 years before we know for sure that the greenhouse effect is here.

In a report that was released by that group last June, it was concluded that a decade after we had confirmed the greenhouse connection, we could expect a global temperature rise of more than 2° F, and an increase in sea level of perhaps three-quarters of a foot. Such consequences would be already in the pipeline so to speak, and we would still have to begin the process of responding.

The greatest single contribution to the growth of the greenhouse warming is, of course, the increase of carbon dioxide, which is released in the combustion of fossil fuels. While human sources of carbon dioxide have been released to the atmosphere since the beginning of the industrial revolution, nearly 200 years ago, the majority of the carbon dioxide released from that source has been released in the last 30 years. In terms of the legislation under consideration here today, it is also significant that we have only been monitoring carbon dioxide in the atmosphere for the last 30 years.

That puts us at an interesting point in time, because, certainly by 30 years into the future, we will be suffering the major consequences of the greenhouse effect. So we can both look backward in time, and look forward, to try to see—and so we are at an ideal time to begin dealing with global climate change as an important policy issue.

One of the things that we have to do, of course, is to resolve the scientific uncertainties that exist, and that can best be done by increasing the quality and extent of our research programs, as is proposed in the legislation that you are considering.

Let me just say a few things about the projected consequences of greenhouse warming, and then make a few observations about the need for the monitoring and research that will help to resolve some of the uncertainties.

The consequences of greenhouse warming are projected to be quite severe. It does not sound like very much to say there is going to be a 2 degree temperature rise, or a 5 degree temperature rise in the global average temperature. However, during the depths of the last ice age, average temperatures were only about 9° F colder than at present. The rise will not be uniform, but is magnified several times as one moves towards the poles. This means the poles will increase in temperature two and a half, or three times more than will the temperature rise at the equator.

This will cause significant changes in weather and precipitation patterns, with major drying and warming predicted for continental areas like the American grain belt. The creation of desert-like precipitation patterns for the midcontinent would of course come just as we are approaching the depletion of many of the large underground aquifers on which we now rely for our crops in that part of the world.

The implication for crops, forests, and other ecosystems are profound. The alleged advantage of carbon dioxide in stimulating plant growth would probably be offset, to a significant degree, by increased drought, altered pest patterns, and, in the area of forestry, as we saw last summer—when things get dry we end up with forest fires. As the climate shifts, we can expect significant species loss, and the loss of forest and tundra ecosystems with an expansion of grasslands and deserts.

Few forests, for example, could move rapidly enough in response to current rates of temperature change with devastating consequences for many of our national parks, forests, and wildlife refuges.

Existing irrigation and water projects might no longer receive adequate rainfall, or, in some areas of the country perhaps too much.

Finally, of particular interest to this Committee, significant sea level rise appears to be an inevitable consequence of global climate change. It is estimated that about half of the 5 inch rise that has been observed so far in this century, is due to the warming of the oceans and the expansion of the water when it warms, and about half is due to the melting of land ice into the oceans.

This will have serious implications for coastal populations, their cities, water supplies, harbors, and estuaries. We get some sense of the consequences of a small amount of sea level change just by noting that the rise in the level of the Great Lakes and of the Great Salt Lake a few years ago, caused great economic hardship and severe disruption. While sea level rise would create strong incentives for urban renewal in some of our coastal cities, the cost of either moving them or building protective barriers would probably be in the range of hundreds of billions of dollars.

The Environmental Protection Agency has done various studies estimating these costs, and even for a modest-sized city like Charleston, South Carolina, the estimated cost of protecting just that one city would be $1.5 billion.

The Dutch, who are of course the premier dike-builders of the world, have recently completed the Deltaworks Project near the mouth of the Rhine which protects a few miles of coastline at a cost of over $5 billion. Globally, more than a third of the world's population live along coasts in sizeable numbers and would be adversely affected by rising sea level.

Various estimates have been made of the loss of land in countries like Bangladesh, where, perhaps, 10 or 20 million people would be displaced by the kind of sea level rise that is anticipated by the year 2050. The flooding of the Nile delta in Egypt would remove close to 20 percent of the arable land of Egypt. Island nations like The Maldives, of course, with the highest point being only about six or seven feet above sea level, would be severely compromised.

In the EPA effects report it is estimated that a sea level rise of 3 feet would cause a loss of between a quarter and two-thirds of the wetlands and estuaries of the United States. Assuming we did not do anything to try to save the land that abuts them, if we built dikes and barriers to protect the areas immediately adjacent, the wetlands could not even migrate, and we might lose as much as 80 percent of those wetlands and estuaries.

I have included an attachment of some diagrams to suggest some of the kind of monitoring and study that needs to be done. Let me just suggest, that as we begin to think about how to respond to global climate change, we clearly need to have a research program, and this includes a monitoring program. We need to know where we are. What is it that we are adding to the atmosphere, and at what rates? I have included in these diagrams some of the data that we have, and although I will not go through all of them here, they might be useful for the record.

The first diagram shows the well-known record of the rise in carbon dioxide as measured over a 30-year time-frame at Mauna Loa. One can readily see the oscillations due to biological activity, and the upward rise in carbon dioxide. The following page shows a similar set of data that is taken from a station near the South Pole, and I include that both to show that we have measured this more than one place on Earth, and also, to point out the gap in that data that occurs in 1964. The reason there is a gap is not because carbon dioxide stopped reaching the South Pole in 1964, but funding from Federal agencies stopped reaching the researchers, and they had to suspend the program for about a year.

The legislation under consideration here today contemplates having a sustained program, I think it is important to recognize that we often talk about how science affects policy. In the case of the polar data on carbon dioxide, we have an example where policy affected science. Fortunately, funding was resumed, but it is important that these records be continuous, and that we are able to continue to collect this kind of data.

Just to give you a sense of what else we know about carbon dioxide buildup, the next figures shows a combination of data going back to the mid-18th century based on samples from ice cores taken by a number of researchers from around the world. It is a rather extensive set of records.

The other diagrams in here simply show other gases that have been measured by researchers at various times, and the thing that is striking about all of these—whether you are talking about methane, or nitrous oxide, or industrial chemicals like chlorofluorocarbons, and carbon tetrachloride—is all of them show an increase from the time at which measurements began.

I have included, in the next-to-last diagram, some data from sea-level gauge measurements at several cities from the EPA effects report. Galveston, Texas; Miami, Florida; Charleston, South Carolina; New York; and Sitka, Alaska.

All but the Alaska data show a rise in sea level over the last 100 years, with a very sharp rise in Galveston, more moderate rises in the other three East Coast cities, and a slight decline in Sitka.

It is important to recognize that when one measures sea level just by putting a gauge out, one is measuring the relative change in sea level and land level, and in fact the land around Sitka, Alaska is rising faster than is the ocean in front of it, which is why it looks like the sea is going down there; whereas Galveston is sinking more rapidly than sea level is rising, which is why there is such a large apparent sea-level rise in Galveston.

But it is important to have this kind of data from around the world so that we can get really good assessments of the problem, and be able to get some sense of how effective our policies are going to be.

There has been some discussion about taking action to slow the rate of release of greenhouse gases before we have all the scientific uncertainties resolved. I think the problem is certainly serious enough that we have to begin some policy actions very soon, but we also clearly need to develop the scientific background further. We know enough now, I believe, to begin taking policy actions, but we need to have a continuous monitoring program so that we can chart our progress and make mid-course corrections in light of new findings. The program needs to be institutionalized in some way so that it can be sustained. I know the bill suggests a 10-year program, but in my written testimony I suggest a 30-year program, which I call the Global Change 2020 Program. It is perhaps unusual, for congressional legislation to commit itself to a program of that length.

But I think such a long term commitment is essential. If we look back, the Mauna Loa record data on carbon dioxide is a 30-year record. We are talking about needing that kind of monitoring for at least 30 years into the future. So I think we need to make a long-term commitment to support such a program by the Congress, and a plan to set up a structure so that the several agencies have a clear sense of mission, and organization so that all of the various agencies in the Government can begin working on this important problem. Thank you, Mr. Chairman.

[The statement of Dr. Moomaw can be found at end of hearing.]

Mr. HERTEL. Well, thank you, Doctor. I think it is a good idea for a longer period. That is an excellent idea, for starters. Other than that, do you support the direction of Mr. Jones' bill?

Dr. MOOMAW. Yes. Certainly I think the direction is very much needed, to have a commitment by the Federal Government and an organization of the Federal Government to begin addressing the research needs of this particular problem.

Mr. HERTEL. You say we have a correct basis of information today to go ahead, but isn't there a huge hole in our data base resulting from our lack of knowledge on ocean systems, just in general? And could you comment on the fact that the President's budget in this area, for NOAA, and other areas of research——

Dr. MOOMAW. Well, I would certainly agree with you there are many holes in our knowledge. When I say that we know enough to go ahead, what I mean by that is that the basic aspect of the greenhouse effect, or the "hot car effect"—as I like to call it—is well-established, and, we know that if we keep putting these gases into the atmosphere, that they are going to continue to absorb radiant heat from the Earth, and cause the Earth to warm up.

What we are less certain about is what the sources of some of these gases are. We do not know a lot about some of the interactions between the oceans and the atmosphere, that will help us get a better handle on the timing of global warming and of climate change, and we do need to do more study on what some of the impacts will be on estuaries and natural systems.

Mr. HERTEL. Do you think we are doing enough in the international areas, with other nations, on this subject?

Dr. MOOMAW. Well, in fact next week, the U.S. will be at the Intergovernmental Panel on Climate Change meeting in Geneva, and I thought that Secretary Baker got us off to a very good start at the first meeting that was held here, in Washington, in January.

I would certainly like to see us being a bit more—I suppose "aggressive" is the right word—on the international front, to take more of a leadership role. I think it is very clear that Prime Minister Thatcher is becoming much more involved in these issues. She held, apparently, a 6-hour cabinet meeting with several American scientists present, to discuss global change issues just a couple of weeks ago. Chancellor Helmut Kohl is apparently meeting monthly with advisors on global change issues. Various other world leaders are beginning to stake out various positions, and to press for conventions, and cooperative research, and so forth, and I would like to see the United States take a leading role in that.

Mr. **Hertel**. Thank you, Doctor. Mr. Saxton.

Mr. **Saxton**. Doctor, I think it goes without saying that the Chairman and I, and the Ranking Member, and many other Members of this Committee are very concerned about this problem, generally. One of the questions, therefore, that we have, is how the United States should proceed in terms of our policy. You are going to be followed, after your testimony, by Dr. Schneider and Dr. Solow, who are going to, I believe, indicate that we need a well-planned, well-mapped-out strategy. And that rather than to move forward in haste, we should decide what it is we are going to do, and make sure that we are on a good footing before we proceed to put in place policies that may not be the right policies.

How would you balance out our extreme desire to be assertive and aggressive with the need for a well thought out policy?

Dr. **Moomaw**. Are you referring to the research area, or the policy response area?

Mr. **Saxton**. The policy response area as well as the research area.

Dr. **Moomaw**. OK. I think, fortunately, there has been a lot of good thinking on the research area, I think that we understand what it is we need to learn more about there. So I do not see any problem in beginning an aggressive program of research.

And I might just add: I was pleased to see in the legislation—there are some statements in the proposed bill, that we cooperate internationally on scientific research. I think it is exceedingly important for the United States not to feel that we have to do the whole job, or to steal the whole show, from a research point of view.

I think it is probably not insignificant that it was a British researcher who initially noticed the Antarctic ozone hole, and the British are now taking the lead in protecting the ozone layer. They had not been very enthusiastic about concerns over depletion of the ozone layer until very recently.

Certainly, in the developing countries, it is important that they play a role in the research on these issues. So I think in the research area, a lot of international cooperation and moving ahead on that front is important.

Mr. **Saxton**. Of course at the same time—pardon me for interrupting—at the same time, in certain areas, I am sure there is a preponderance of evidence that says we ought to move, policy-wise, in certain directions.

Dr. MOOMAW. Yes.

Mr. SAXTON. And relate that to what we were involved in with the Chairman, then, as a Member of the Committee, last year, when we passed a law and did a lot of work on this Committee with regard to the condition of the ocean, and we passed a law which said you cannot dump sludge in the ocean anymore, legally, after 1991.

Dr. MOOMAW. Right.

Mr. SAXTON. And people kept saying to us, well, you cannot prove it is harmful.

Dr. MOOMAW. Yes.

Mr. SAXTON. But we said, yes, but there is a preponderance of evidence that says that we ought to move forward in this area in terms of a new policy.

Are there areas like that, that you can identify now, that we ought to——

Dr. MOOMAW. Yes. I believe there are, and, to use another analogy, I think that in the 1970's, when the Congress said that we should stop using chlorofluorocarbons as aerosol propellants, that was a prudent policy given what we knew and what we did not know at that time about ozone depletion.

The Congress did not say let's take chlorofluorocarbons immediately away from refrigeration and all the other uses, but it was prudent to take some action. So as a precautionary measure, Congress passed legislation banning the use of CFCs in aerosol cans. Now it will be easy for the Europeans to abandon the use of CFCs in aerosols because we have shown the way. So I think it was a very prudent action. Now that we know that there really is a very serious problem, we may well wish we had done more. We have gone from a preponderance of evidence to overwhelming evidence, that depleting the ozone layer is really going on, and going on in a serious way.

Likewise, in the global warming case, I think it is very clear that we could begin to reduce emissions of carbon dioxide by introducing energy efficiency strategies into our economy, into the Government, that would not only be a good thing for the greenhouse effect. It would be a good thing for the economy.

Our economy is very inefficient compared to our major competitors, Japan and West Germany, in terms of the amount of energy that we use. We use twice as much energy to create a dollar of gross national product as do our major international competitors.

So suppose there turned out to be no greenhouse effect. We would not have made a mistake to move on the energy efficiency front. Just from an economic point of view, reducing balance-of-payments problems alone would justify energy efficiency measures.

Certainly increasing reforestation, would help to slow the buildup of carbon dioxide. Planting trees can absorb carbon dioxide. Again, there are enough additional social benefits, and economic benefits from doing that, that it is an action worth doing, and something we know will make a difference for climate change. As long as we have enough knowledge to know that that is moving in the right direction.

So I think choosing policies that we know are moving in the right direction, and have multiple additional benefits, is perhaps the way to start in the policy field. I mean, I think it would probably be a mistake to decide right now that we should restructure the whole industrial society in the next 10 years. That is just not going to happen. Maybe 50 years from now, we will have had to do that, but we can begin now doing things which make sense to do anyway.

Mr. SAXTON. Thank you. Mr. Chairman, I have no further questions at this point. Thank you, sir.

Mr. HERTEL. Thank you, Mr. Saxton. And thank you, Doctor, very much, for your testimony.

Dr. MOOMAW. Thank you.

Mr. HERTEL. We will include your written statement in the record at this point and we will have further questions for you to be answered, at your leisure, in writing.

Dr. MOOMAW. All right. Thank you.

Mr. HERTEL. In the interest of a schedule conflict, we are going to take the industry panel next. Mr. Robert Slocum, Jr., Executive Vice President, North Carolina Forestry Association, Incorporated, and Ms. Susan C. Moya, Manager, Energy and Natural Resources Policy, Resources Policy Department, the U.S. Chamber of Commerce. We will include your written statement in the record at this point, Mr. Slocum.

STATEMENTS OF A PANEL, CONSISTING OF ROBERT W. SLOCUM, JR., EXECUTIVE VICE PRESIDENT, NORTH CAROLINA FORESTRY ASSOCIATION, INCORPORATED; AND SUSAN C. MOYA, MANAGER, ENERGY AND NATURAL RESOURCES POLICY, RESOURCES POLICY DEPARTMENT, U.S. CHAMBER OF COMMERCE

Mr. SLOCUM. Thank you very much, Mr. Chairman. As you noted, my name is Robert Slocum. I am the Executive Vice President of the North Carolina Forestry Association.

Prior to this, I was Vice President for Forest Policy and Research with the American Forest Council, here, in Washington.

In 1984, we put together, along with EPA and several other organizations, one of the first conferences on forest effects and global climate change.

In North Carolina, we are certainly concerned about the potential impacts of global climate change. We recognize that significant changes in our environment will certainly impact our forest resources, and the economic and environmental benefits we get from them.

To put that in perspective, in North Carolina, we have 18.5 million acres of timberland, fourth in the Nation, and it supports a forest products industry that ranks second in the State in value of shipments, employment, and payroll.

Additionally, these forests provide habitat for over 80 percent of the game species hunted, and for fresh-water fish. Some 2 million people spent over $1 billion in 1985 for hunting and fishing in our State. Potential impacts on the health and productivity of these resources are certainly important to us.

The establishment of a coordinated, focused program to identify goals, research priorities, and approaches for global climate change research is essential. A program should be designed to provide a sound scientific basis for developing national and international policy on global change issues.

The concepts embodied in H.R. 980 appear to meet this need. I would also agree, very strongly, with earlier comments about the need to make this a very long-term research program. We are dealing with a long-term problem that has developed over many years. We are not going to solve the research needs in ten.

As was earlier noted, too, it is important that we recognize significant scientific uncertainty and speculation surround the issue of global climate change. There are many unanswered questions, and many of these questions must be answered to insure both the future productivity of our forests and to avoid ill-conceived mitigation programs.

H.R. 980 directs the Federal Coordinating Council for Science, Engineering, and Technology to develop a coordinated research plan which will establish the goals and priorities for Federal global change research.

The bill also identifies and lays out research responsibilities for several agencies. In this context, I would like to urge, that as work on this proceeds, that it be recognized that the research responsibility for certain areas be given to those agencies that are best suited to handle that research.

For example, I would submit that terrestrial effects research is best handled by agencies such as the U.S. Forest Service and the universities that they cooperate with.

I would also recommend that funding for specific research be allocated to support the best science available, and not just to support an agency. Various forms of competitive grant programs have a proven track record of stimulating new innovative research to address specific needs.

You had asked about some policy responses that might be available on the forestry side, and from the forest industry.

Now despite the uncertainty surrounding this issue, we believe it is not prudent to simply await the results of research. There are several actions concerning forest management and utilization that can both directly and indirectly help minimize concentrations of CO_2 gases in the atmosphere.

The planting of new forests and the regeneration of forests after harvest will certainly help consume carbon dioxide. The American Forest Council estimates that we are now planting some 2.3 billion seedlings a year, covering some 3 million acres.

These new forests will consume up to 9.2 million tons of carbon dioxide a year. Additionally, the United States should work with other nations to encourage the regeneration and management of their forests.

Tropical forests can be managed for sustained production of fuel wood, forest products, and the many other benefits provided by well-managed forests.

Land managers should manage forests more productively, and in a healthier condition, in order to increase carbon dioxide consumption, and reduce their susceptibility to insects, and disease.

It should be pointed out, too, that over-mature forests, those particularly where no management occurs, become net sources of carbon dioxide as the natural death and decay of the wood releases carbon dioxide in excess of what is being consumed.

Manufactured wood products that serve to store carbon dioxide in structural materials might be substituted in many areas for other materials. Proper treatment of wood can prolong the useful life of these products by up for 40 times.

Renewable wood should be utilized, in many cases, in place of conventional fossil fuels that release carbon dioxide. The forest products industry is moving toward becoming 100 percent self-sufficient in generating its own energy through the use of wood wastes.

Forests, as well as individual trees, serve to shade and thus cool the Earth's surface, which can reduce air conditioning costs as well as energy use. Planting of shade trees could, according to some sources, potentially offset carbon dioxide emissions by 18 million tons a year.

I also feel that I should point out that I think that some of the earlier statements made about the dire consequences to our forests from global change, I think are somewhat overstated. The conference in Boulder, in 1984, and subsequent research by both the Forest Service, the forest industry, and universities, have shown that—at least from our standpoint—that our forests and nature are both resilient and adaptive.

Mr. Chairman, I would also urge that you and your colleagues consider how seemingly unrelated actions on taxation and regulation affect our ability to properly manage our forests.

The recent elimination of the capital-gains tax differential for timber appears to have adversely affected forest management by many private landowners.

Also, the continued proliferation of environmental regulations without consideration of costs or benefit are also causing problems from a forest management standpoint.

The objectives of the global climate change research program are sound. Attempts to respond to hypothetical climate changes without a strong scientific basis could be futile and very costly.

We must monitor, understand, and ultimately predict global change. Only then can we develop a sound and defensible policy on this issue. Thank you.

[The statement of Mr. Slocum can be found at end of hearing.]

Mr. Hertel. Thank you, Mr. Slocum. I want to ask one question at this point. You talked about the elimination of the capital-gains tax differential. Was that done in the Tax Reform Bill?

Mr. Slocum. Yes, sir.

Mr. Hertel. I still have not heard of anything good being done in that bill, but we will have more questions for you later.

At this point, I would like to ask Dr. Schneider and Dr. Solow to come up and join us. You will be testifying right after Ms. Moya. Ms. Moya, do you want to go ahead at this point.

STATEMENT OF MS. MOYA

Ms. Moya. Thank you. I am Susan Moya, Manager of Energy and Natural Resources Policy for the U.S. Chamber of Commerce. I am appearing today on behalf of the nearly 180,000 business, State and local chambers of commerce, and trade and professional associations represented by the Chamber.

We appreciate this opportunity to express our views on H.R. 980. The Chamber supports, in principle, the bill's provisions to coordinate Federal research and national global climate change policy efforts, and to establish the multi-year research plan.

My comments will focus on the Chamber's strategies for action on global climate change, and how H.R. 980 relates to this strategy. And in response to a request that the Chamber share its views on the possible economic and trade impacts of global climate change, I will briefly address this as well. However, appended to my written statement is a Chamber paper that is being presented today, which goes into the economic and trade effects in great detail.

Mr. HERTEL. We will include that in the record at this point as well as your written statement.

Ms. MOYA. Thank you. I would like to preface my remarks by stating that global climate change is both a major scientific issue as well as a political one, and that the two should not be confused. There are essentially two unknowns from our perspective. The first is, what is the critical point when greenhouse gases will accumulate to the point where heat radiation from the Earth will be trapped, and the atmospheric temperatures will increase?

The second unknown is, how much of a temperature increase can the society assimilate easily?

The Chamber believes that any increase in the atmosphere from man-made causes is cause for the most serious concern, and the right action, because the wrong action could create more severe consequences.

And for that reason, the Chamber is now advocating parallel courses of action. One is to gain a better scientific understanding of global climate change. H.R. 980 would start us on this course by directing, prioritizing, and beginning to institutionalize Federal interagency global climate change research efforts.

The second parallel course of action is to take those steps now that make sense on their own merits, regardless of whether the global atmosphere is warming. And of course the U.S. has an important role to play, but it is important to recognize that this is a global problem that requires international cooperation.

No one country's actions, however ambitious, can significantly affect the global climate change situation.

With respect to the Chamber's first course of action, gaining a better scientific understanding, H.R. 980 provides coordination among the many Federal departments and agencies through the FCCSET, the Federal Coordinating Council for Science, Engineering and Technology, which is part of the Executive Office of the President.

The Chamber fully agrees with one of the bill's findings, and that is, quote, "Development of effective policies to abate, mitigate and adapt to human-induced and natural global climate changes will depend on our ability to understand global environmental processes, predict global environmental changes, and distinguish between the effects of human activities and the results of natural changes."

We also commend the bill's sponsors for recognizing the value of a multi-year research plan to identify priorities for scientific research and monitoring efforts on global climate change.

However, we question, based on past experience—whether H.R. 980's allotted 1 year is sufficient time for FCCSET to adequately develop a plan for submission to Congress, particularly in light of the fact that the plan will be subjected to public review and comment.

Additionally, the Chamber believes that in order for the FCCSET, and the Council on Global Environmental Policy to be effective, consideration needs to be given to sufficient operating money for those two different councils.

And finally, the Chamber strongly supports H.R. 980's provisions to require FCCSET, at least every 3 years, to revise its plan and submit it to Congress, along with any recommendations regarding any additional research.

These provisions we believe provide flexibility and allow for strategy and policy adjustments as more is learned about global climate change from the science standpoint, and new technologies are introduced into the marketplace.

The role of science clearly is to provide direction and scope for policy development, but that is not to say that there are not a number of things that we can be doing now, on a parallel track, along with the scientific research efforts.

These policies should make sense on their own merits, and when more is known and we have a better understanding, then we can decide what other policy actions we need to take.

These recommendations are discussed in detail in my written testimony, but, briefly, I will hit on a few of them now.

One. We need to educate people around the world about global climate change. Much more is needed in this area. Secondly, we need to implement actions to mitigate climate changes caused by man, and assure that they make economic, social, and environmental sense. And we need to assist developing nations in joining the global efforts, while, at the same time, assuring that they are able to maintain their own economic growth.

Another one is to remove unnecessary impediments to the adoption of alternative energy strategies, technologies, and conservation.

Regarding the question to the Chamber about the economic effects of global warming, there is a broad consensus that global warming can occur, but may not if mitigating steps are taken.

To repeat my earlier statement, the controversy is really over how much change can be expected, when it will happen, and where its effects will be most evident.

There is agreement that sea level will rise, the wetlands will flood, that salt water will infuse fresh-water supplies, and that there will be changes in the distribution of tree and crop species, and agricultural productivity.

And as evidenced by the number of bills that have been introduced in the Congress, and the fact of all the international interest in this issue, there are a number of likely actions that will be taken by various governments throughout the world. The paper goes into that in detail, but specifically they are—the first is that there will be actions to reduce the emissions of CO_2, by reducing the use or mix of fossil fuels. The second would be to reduce the emissions of potential pollutants. The third is to improve energy efficiency. The fourth would be the banning or restricting of the manufacture of certain chemicals. And the fifth would be to seek natural emissions of key chemical compounds.

The bottom line on the economic and trade effects of these five courses of action would be that these worldwide strategies to respond would have mostly negative effects on trade and the economies of developed and developing nations.

However, these negatives must be weighed against the possible future outcomes for global warming. Because society does not have the resources to hedge against all possible consequences of global warming, the Chamber believes that its parallel courses of research and action provides the appropriate balance between information-gathering and steps that we can take now. The Chamber appreciates this opportunity to present its views to the Committee, and looks forward to working with the Committee as this important issue develops. Thank you.

[The statement of Ms. Moya can be found at end of hearing.]

Mr. **Hertel**. Thank you, Ms. Moya. I appreciate your two-track method approach, and very much appreciate your ideas for improvements in strengthening H.R. 980. I did want to comment, when you talked, again, about exploring alternatives to fossil fuels, such as wind power, photovoltaic cells, and solar collectors, I think once again the Tax Reform Bill decimated the earlier provisions that we had in to encourage that type of research and use. But let me go on at this point because two of the four of you on the panel have planes to catch. That is why we brought you up here.

But I do like to have industry and science sitting together at all times.

[Laughter.]

Mr. **Hertel**. We have Dr. Schneider, next, to testify.

STATEMENTS OF A PANEL, CONSISTING OF DR. STEPHEN H. SCHNEIDER, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH; AND DR. ANDREW SOLOW, MARINE POLICY CENTER, WOODS HOLE OCEANOGRAPHIC INSTITUTE

Dr. **Schneider**. Thank you very much. Actually, as a veteran of hearings on the subject of climate change, in general, and greenhouse warming, in particular—I guess I started back in 1976 with Congressman Brown's Subcommittee on Science and Technology on the Climate Bill—I must say I was very impressed by the previous testimony from Ms. Moya and the Chamber of Commerce. There has been substantial convergence between the views that have taken place, then and now.

For example, the views she mentioned having to do with doing sensible things now, it was exactly the same kind of idea that we heard from Bill Moomaw, from the environmental panel. I could not say that 10 years ago, if the issue of fluorocarbons was discussed, that you could have put the same people on the same podium without putting a wall between them, and I think that kind of cooperation would be essential to——

Mr. **Hertel**. I might comment, at this point, that today's Wall Street Journal has a front-page article about Detroit and the auto industry in this same regard, trying to look at what they can do, rather than just objecting to some things that they are being called upon to do. So, we do certainly welcome the Chamber's, and your testimony especially this morning, to talk about things that we can do, not only now, but that we can work on together in the future, Dr. Schneider.

Dr. **Schneider**. And in fact I think it is also good business for the Chamber to be concerned about this because the environment is an economic good on the one hand, and, on the other, if symbols of environmental change lead to overreaction, that can hurt industry, whereas graduated change, which may have some initial price, ultimately can be better for everybody.

But before we believe that this entire issue is that easily solved, I think I had better go back and address the charge you sent to me in your letter, Mr. Chairman, which is to first try to put some perspective on the noisy debate that has been going on about whether there is or is not a greenhouse effect, whether there is or is not warming. I know that Dr. Solow will talk, in some detail, about the climate trends, so I will only briefly go over them; but I will try to put some perspective on that, and then ultimately come back with a few specific comments on H.R. 890.

First, there was lots of publicity on this subject this past summer. If I judge by the modulus of how many phone calls come into my office from the press, we went through some quantum leap. I would say, in the 1980 heat wave, I probably had 25 in the summer, people asking me is this the greenhouse effect, and in 1983, in the heat wave in the Corn Belt, maybe there were 25 in a month as opposed to the summer.

In 1986, in the Southeast drought, I probably had 25 in a week, and this year, easily 25 in a day. My office was transformed and we could not get any work done for three months, just trying to deal with public information.

So something has happened, you know, that catalyzed opinion. You could not go anywhere without reading a headline about the greenhouse effect, or watching it on television. In fact I found myself in the ironic position of having spent 15 years trying to get people's attention, having to slow them down, saying, wait, I am glad we have your attention. You have the right degree of consciousness but it is not because of one random event. And I worry about what happens when we get the inevitable cold year. Will people say: "Ah-ha, it's not true."?

So, we have everyone's attention. Now I want to try to put some perspective on what the actual issues really are.

The primary basis for concern and interest over the greenhouse effect, as a scientific proposition, is the well-established theory—it is a theory, but so is gravity a theory. I mean, it is not important whether the greenhouse effect is a theory; but whether it is valid. And it is the very well-established proposition that carbon dioxide, water vapor, methane, other kinds of gases, let more sunlight through than they let another kind of radiant energy—infrared heat—escape.

Now there is no doubt of this. It has been established through literally hundreds of laboratory measurements, thousands of aircraft and balloon observations, and billions upon billions of satellite measurements.

So the greenhouse effect as a scientific proposition is known, and in fact the greenhouse effect, by itself, is a very good thing. If it were not for the greenhouse effect, this Earth would be below freezing, on average, in temperature.

We would not be here unless we had a way to survive as below-freezing units, and it maintains something on the order of 50 or 60° F warming relative to a planet without an atmosphere. So, where is the controversy and the concern? It is that a change in the amount of the stuff which makes this good greenhouse effect could be occurring on rates that are 10 to a 100 times faster than nature normally changes that gaseous envelope, and the 50° F of nice warming that we have to which all our ecosystems are adapted, and we, too, could change to 60° F. And could it happen in 50 years or in a 100 years? So the debate is over the rate of change of the natural system, and what has been called the "greenhouse effect" in the press. And the controversy is not over the greenhouse effect. It is over whether we are talking about 1, 5, or 10° F future warming; whether it will be wetter in India and drier in Iowa; whether the sea levels are going to go up centimeters or meters; and whether this is good or bad, for whom, and ultimately, what to do about it.

So, there is plenty of controversy to go around, but, ironically, it is not so much over the issues we read about. For example, with the 1988 drought being associated with the greenhouse effect, there were understandable counterreactions from a number of scientists, who pointed out that individual natural fluctuations in the system that have occurred will continue to occur.

What cranking up the temperature does, is it changes the probability of certain events. I mean, we have calculated, for example, the odds of getting a heat wave in Washington, D.C. What are the odds of getting five days in a row with temperatures above, say, 95° F in July? And I like to think of the climate in the metaphor of dice. You know, nature is going to roll heat waves like that. It will roll cool waves. Well, the odds of that kind of an event are approximately about one in six; one face of a die.

What if you increase the temperature by 3° F and you do not change anything else—that "if" is important because it assumes that the basic climatic structure is unchanged, just heated. That is an assumption. We have no idea if that is true. If we make that assumption, then the odds of that five-day-in-a-row, 95° heat wave, then goes from one in six to three in six.

In other words, you have changed the dice. You have "loaded" them by now having three faces coming up a heat wave. So, that is essentially the nature of the change, and it is easy for the public, or any lay people, to confuse individual events which are caused by nature with a system in which the probability of extreme events has changed.

OK. The second thing, then, is how do we know how much warming there will be? Well, as Dr. Moomaw pointed out, we have to make assumptions about what will the human activities be. At the very base of this issue is understanding human behavior. What will be the technologies of the future?

If we use coal, we put in twice as much CO_2 as if we use natural gas. If we use solar or nuclear machines, we put in no CO_2 except that which it takes to build or decommission them. So, the technology is important.

The second term that counts is the amount of technology per capita. Well, that is pretty politically volatile stuff. Technology per capita is standard of living. That is what we have, and lots of countries, like China and India, want. So that is the second term, and the third term is population. And there is no way to escape this so-called population multiplier that John Holdren and Paul Ehrlich pointed out, I guess 20 years ago, because it is just simply arithmetic.

That the total emission is equal to the technology times the standard of living times the population. That makes it very difficult for those of us in the physical sciences to try to project the future, because to predict all of those factors involves making projections that nobody can be certain of.

So what we must do, in spite of the fact that it is difficult—and I agree with Mr. Slocum, that scenarios are painful—but we really have no other choice, if we are being honest, and we typically make high, medium, and low scenarios of what the future might be like.

The good news in all this uncertainty is that should we not like one of those scenarios and wish to avert one, we have options. We can work on either the technology or the standard of living, or the population. Different countries will be more easily able to work on one or the other of those terms.

So it is complicated but gives us options. The second question is, how do we decide—once we have a scenario of how much change there is going to be—how warm it will be? Well, in that, we turn to the best physical theories that we have, which we translate into mathematical models, and we ask the model what happens if we increase carbon dioxides, methane, and other gases. And then the models, based upon the particular scenario we choose, give us answers.

Now, these models are also uncertain to a factor of two or three, in global terms, and uncertain to larger amounts than that in terms of where it is wetter and drier. The one thing they all agree on is that if the greenhouse gas trends that we now see continue on past the next several decades, that there is a high likelihood of change that is outside of the range of precedent within, let's say, the era of civilization. We are talking about changes greater than several degrees Celsius. Once you get past about 2° C, you are beyond natural experience at least in the past 10,000 years.

So, the models pretty much tell us that. But the models have substantial uncertainty. The principal greenhouse gas in the atmosphere is water vapor, not carbon dioxide. Water vapor changes when you heat the planet up. You get more of it. That amplifies the warming.

On the other hand, it makes more clouds, we think, but we are not sure. If it makes more clouds, and they are brighter and whiter, it cools the planet back down somewhat; but if the clouds get taller, their tops are cold, they actually enhance the greenhouse effect. We do not know that feedback to better than about a factor of two or three, and, quite frankly, I think we are unlikely to know that to better than a factor of two or three in the time-frame of the next decade.

We might be able to narrow it faster than that, but at present levels of effort, and with a fragmented effort, I would be surprised.

The next thing that we have to predict, which is most important for economic analysis, is what is the regional distribution of climate change. Where is it wetter and where is it drier, for example, and what is the timing of those changes? And that is even tougher, because to answer that question—and this certainly is in this Committee's purview—we have to know what happens in the oceans.

You know, it may seem ironic, but to know whether you are going to get a drought in Iowa, we need to know what is happening in the middle of the Pacific and the Atlantic. That is very important. And the time rate of change, of temperature in the ocean, is not going to be uniform.

High latitudes will not warm up at the same rate as the tropics. The middle of continents will not warm up as slowly. So what that all means is we skew the system and create wind systems that are unusual. OK. What we can do is say change, but it is very difficult to give details.

We can say drier is more likely than wet, or simply because if you heat the place up you evaporate more water from the soil, but we do not know whether it is going to rain more, or rain less. We only know that it could be substantially different, and almost everything agrees on warming. And ultimately, we have to ask the question, so what? If it is wetter in India, for example, as some models suggest, is that an advantage? Would that give them the kind of reliable monsoon they would like?

Well, if you put the half trillion dollars into the infrastructure to prevent flooding, and to capture the water, it could be an advantage; but if you do not invest, if can actually be a risk. So good and bad depends as much upon your capacity to adapt, which means you need flexibility in management and flexibility in resources in the future, in order to take advantage of change.

But the one thing that is clear in this is, the faster things change, the less easy it is for us to forecast those changes. And the less easy it is for us to forecast the changes, the more difficult it is to adapt, and, the faster things change, the more likely it is that we will have surprises that we cannot forecast.

So, speed of change is, to me, that which I fear. Let me close the technical part of what I was going to say with one observation.

You will hear later, from Dallas Peck, from the U.S. Geological Survey. One of the things that they do is they look backwards in time, and try to figure out what happened to the climate in the past, and what happened to the forests of the past, for example.

This is key, because the last ice age, which ended about 10,000 years ago, was 5° C, 9° F, colder than the present interglacial age that we are in now. And that is an important number to remember because it took about 5000 to 10,000 years for the ice age to end. Somewhere between 15,000 and 5000 years ago, the world warmed up, 9° F; sea levels rose 300 feet; the present hardwood forests that

Mr. Slocum's industry so now enjoys were much decimated in North America, were sort of hiding in refuges in the South, and most of what is now the Corn Belt and the hardwood district was populated with the boreal forests that now live up in Canada.

Well, the rate at which these things changed were forests moving on the order of a kilometer a year at most, because that is about as fast as they can move in response to climate. But the climate changed at average rates on the order of 1° C per 1000sa years.

What we are talking about now is a better than even betting chance of change at the rate of something like 6° F in a century, and the numbers range from 1 to 10°, but that is the kind of numbers we are talking about.

So we are looking at rates of change that are 10, or in some cases, a 100 times faster than natural rates of change. Now most of the forest ecosystem models I have seen show very substantial and quite dramatic changes in species distribution. It does not eliminate trees. It creates a new habitat.

The problem is many species cannot move fast enough. So then we have to plant them in new places, and once we start planting what happens to the indigenous species? The faster things change, the more burden it puts on us to try to guess what we are doing, and the faster things change, the tougher it is for us to do it. That is why, ultimately—and I will come back to close by focusing on H.R. 980—why I so welcome the idea of coordinating the disparate Federal efforts in this regard.

In fact I particularly applauded in the bill the goals statement, because in the goals—if I could just turn to them, briefly—in the draft that I have received, you point out, A, the goal to advance scientific understanding of global change, and B, provide a basis for policy decisions relating to global change. I think the latter point is critical, because there is often a confusion with people who say, well, until we have more scientific evidence how can we decide?

The first thing I have to say is that whether or not to react to any degree of uncertainty has nothing to do with science. That is a personal value choice which depends more upon whether we fear investing present resources as a hedge against future change, or whether we fear more that future change descending without trying to either slow it down or make the future more adaptable.

That is why I was so delighted to hear the Chamber's presentation, agreeing that the priority list for acting, where you get insurance against catastrophic climate change and at the same time solve other social problems, is, obviously, energy efficiency, renewable systems of development, and so forth.

In fact my own personal view—and I am now talking about policy choice in this case rather than policy analysis—my own personal view is that such actions are already overdue. We need to take a strategic viewpoint—I mean, after all, we do not use economic calculus to determine the scale of a military investment. Most of us buy personal insurance. It is not based upon 99 percent certainty or 95 percent certainty that scientists like so much.

It is based upon consequences that we do not like, with probabilities that are high enough to make us nervous. We make strategic investments, and we then use economic calculus to figure out how best to apportion those investments once we have made a strategic choice.

Well, to me, there are national security implications in rapid environmental change, and sea level rising, and so forth, and that energy efficiency is a strategic issue, both from the point of view of decoupling our dependence on foreign supplies, reducing air pollution, reducing greenhouse effect, improving the competitiveness and efficiency of America products. You have heard the litany before.

And the key is, the climate change simply gives you another reason, gives you another reason why it is, in my opinion, cost-effective, to consider making such investments.

Finally, to come back just on a more mundane level, to the language in the bill. I applaud it because it is comprehensive, and it mentions the wide-ranging number of Federal departments that need to be pulled together—oceanography and atmospheric science, and biology, and so forth.

And, indeed, the parallel in the academic community is the need for interdisciplinary research; getting biologists to work together with oceanographers, and so forth, and we have as much trouble doing that in academe as you do in Congress, trying to get these cross-cutting issues attended.

But as far as you have gone, I hate to say, but we need to go even further. In my opinion, the bill—while I would not change anything—I would consider adding several points. For example, on page six—and I outline this in my written testimony—lines one through three, you talk about studies to understand physical, chemical and biological processes responsible for changes in the Earth's system on all time scales. Absolutely correct. But what is missing is an additional point which recognizes that there is equal uncertainty in human behavior. What will be the demographic, engineering, and standard of living of the future? We really need to address that, and, in my opinion, with co-equal weight.

Additionally, we need new points, and I, in my written testimony on page 16, note that we must include something to the effect that the social and political forces driving these changes need to be examined. We also need to coordinate studies of the impact of global change scenarios on water resources, agriculture, forests, coastline protection, wetlands, human health, and urban infrastructure. In other words, we must as the "so what" question.

Why should we worry about a problem if we do not understand what its potential impacts are? It is very difficult to do cost-benefit analysis when you have no idea of what the costs are.

And, I would say that the latter analysis is part of the policy analysis issue rather than the policy choice, so far. It is not a value question to do the analysis of cost. The values are how to weigh them against the various options.

And then the last thing I would say is on page eight. There, you are dealing, for example, with the NSF responsibility. I would consider adding a phrase. That you would want to add a task of forecasting social behavior that could influence land-surface alterations and trace-gas emissions.

I would also, in that long list of agency coordinations, add the U.S. Department of Agriculture, which I think needs special responsibility to deal with crop and forest impact assessment policy analysis. In fact I have myself run, for the Forest Service, two workshops, and there will be a third one this year, on forest climate interactions. I know they are very interested.

The Bureau of Reclamation, the Army Corps of Engineers, certainly need responsibility for determining water-supply implications of various scenarios. Again, that "so what" question. I think we need a point seven, in which Departments of Defense and State should be given responsibility to look at the national security implications—for example, of changing balance of payments, if we have a change in agricultural advantage.

We also want to look at what happens if there is an ice-free Arctic, or what happens if Bangladesh is flooded. There are migration issues. And these are national security issues, which I think are as legitimate as the kind of scenarios that we correctly run, now, on other, I think, less probable military threats.

And finally, I would look to the Smithsonian Institution as a possible agency for responsibility in determining the impacts of global changes on biodiversity. So my list is not criticisms of the bill, which I applaud, wholeheartedly, but simply additions, making your job even more difficult since I recognize it is tough enough to tend to cross-cutting issues in academic areas. We are locked in departments, and I realize that Congress has the problem of committees that have special responsibilities for energy, merchant marine, and so forth.

But since the environmental reality is cross-cutting, we have to be bold in our institutional capacity, and try to make our institutional response deal with that same cross-cutting reality. Thank you, Mr. Chairman.

[The statement of Dr. Schneider can be found at end of hearing.]

Mr. HERTEL. Thank you, Doctor. Well, because money is an issue, if some of the departments can do it out of their existing budgets, to the greatest extent, and existing personnel, that is very helpful.

We are going to be drafting a substitute with many of the ideas that the panel, so far, today, has given us.

Dr. Solow, we will call on you, now, and I apologize for your name being misspelled on the witness list.

STATEMENT OF DR. SOLOW

Dr. SOLOW. Thank you for giving me the opportunity to testify before this Subcommittee. My name is Andrew R. Solow, with a "w".

As Dr. Schneider has described me elsewhere, I am a young statistician at the Woods Hole Oceanographic Institution in Massachusetts.

In spite of my youth, I am a member of the Climate Trends Panel established by the National Climate Program Office, and also a member of the Scientific Working Group of the Intergovernmental Panel on Climate Change established by the United Nations Environmental Program and the World Meteorological Organization.

My work in the area of climate change has focused on the analysis of climate data, with particular attention to the problem of detecting the onset of climate change. I have also worked on problems relating to decision-making, and the value of information under uncertainty.

A few of the key points about the climate change issue are worth emphasizing. Atmospheric composition is changing, in large part due to human activities, like the consumption of fossil fuels and the development of agriculture. Because the Earth's climate is linked to atmospheric composition, this has led to justifiable concern over the possibility of global warming and its potential consequences.

The appropriate human response to climate change, which may include measures designed to avoid climate change, or to ameliorate its effects, depends on the timing, nature, and magnitude of the change. A response that is efficient under a rapid change of large magnitude may be a costly mistake under a slower change of more modest magnitude.

Unfortunately, substantial uncertainties exist about climate change. Much of our information about climate change comes from experiments with climate models. The results of these experiments are sometimes treated inappropriately, in my opinion, as forecasts of future climate.

Climate models do not perform well at reproducing the recent behavior of climate. For example, these models predict that a global warming of at least 1° C should have occurred over the past 100 years in response to increasing levels of atmospheric carbon dioxide.

Although there appears to have been some warming over that period, it has been no more than half a degree Centigrade, and possibly much less.

Moreover, there is no clear evidence that any warming that has occurred has been due to an enhanced greenhouse effect. In that case, not only have the models erred in predicting past greenhouse warming that did not occur, but they have also erred in not predicting past warming that has occurred for other reasons.

There is disagreement among climate models in forecasting future climate. For example, the forecasts of global warming that would accompany a doubling of the level of atmospheric carbon dioxide, the timing of which is itself uncertain, range from 1.5° C to 5° C.

The consequences of a 1.5° C warming would be very different from those of a 5° warming, as would be the appropriate policy response. Among forecasts of regional effects, the disagreement among the models is even greater.

These results clearly indicate that there is a great deal of uncertainty over future climate. I want to stress that these difficulties do not have to do with climate models which were never intended to be used for long-term forecasting, but with the way in which the results of these models have been interpreted.

In many ways, climate modelers are the heroes of climatology, and there are many examples of the use of climate models in furthering our understanding of global climate. Existing climate data suffer from a number of problems, including systematic error, due, for example, to the urban heat island effect, and incomplete spatial coverage. Apart from this, the analysis of these data reveals a complicated picture over the past century, both globally and regionally.

For the United States, a careful analysis shows that there has been no net warming and no net change in precipitation over the past century.

Although the United States covers only a small fraction of the Earth's surface, it may be the only large area for which enough reliable data are in hand to support such a careful analysis. As a statistician, I find these results compelling, particularly as they pertain to the detection question.

Globally, the available data suggest that there has been some slow, irregular warming since the 19th century. For a number of reasons, this warming appears to be due mainly to natural climate variability, rather than to human intervention in the carbon cycle.

In any case, it is important to recognize that the warming in the 1980's is not strikingly different from warming that occurred during the 1890's and the 1920's.

With regard to the question of whether accelerated greenhouse warming due to human activities has begun, it is time to stop waffling. Existing data do not support the conclusion that it has.

There is a belief among certain scientists that the introduction of uncertainty changes the policy-making process into a purely subjective exercise. By this, they mean that there is no need to justify their policy recommendations on any other basis than their personal feelings.

In fact there is a well-developed methodology for incorporating uncertainty in a rational and systematic way into the policy-making process.

The basic result of applying this methodology is that a balance is struck between potential benefits, potential costs, and the probabilities of different outcomes.

It is certainly possible, and probably desirable to incorporate a preference for caution into the policy-making process. In general, however, this is not the same thing as assuming that the worst possible outcome is sure to occur, even if it has a very small probability of occurring.

It is important to remember that we face a number of problems with potential consequences at least as great as climate change. In facing these problems, we do not act as if the worst possible outcome is sure to occur, nor should we act this way in facing the problem of climate change.

A large-scale policy response aimed at sharply and rapidly curtailing the human activities that contribute carbon dioxide to the atmosphere would be expensive and disruptive.

After all, these activities are not pursued with the sole purpose of disturbing the atmosphere. Although it would certainly be a mistake to expand these activities recklessly, given the current uncertainties about climate change, and about our ability to deter it, I do not believe that such policies are justified by fears of climate change alone.

On the other hand, it may be appropriate to adopt more modest measures, particularly if they are justified for other reasons. The best way to resolve uncertainty is to gather information. Information has real value because it reduces the likelihood of costly policy errors. In the case of climate change, the gathering of information may also have a cost, because it may involve postponing a more active response.

However, on the basis of current information, I believe that the benefits of further research are very great, and that postponing a more active policy response, even by several years, is very unlikely to alter the ultimate outcome of climate change.

By the way, it is only prudent that part of this research should focus on the design of policy responses that could be executed relatively rapidly in the event that further information points to the likelihood of significant and costly climate change.

To give a small example, as recently as 1980, certain scientists suggested that in response to global warming sea level could rise by as much as 8 meters. The consequences of such a rise in sea level could be catastrophic. By 1989, the same scientists had modified their estimates of likely sea level rise to no more than 2 meters. In this case, the passage of time has helped us avoid a potentially wasteful overreaction.

While some see a danger in expressing even legitimate doubts about the possibility of catastrophic climate change, there is also a danger in the way in which the recent discussion has evolved.

It is important to realize, that by acting as if catastrophic climate change is lurking around the corner, and by associating in the public's eye certain short-term meteorological events with long-term climate change, that we run the risk of losing the public's attention and confidence, should climate not start changing dramatically very soon, or should other kinds of meteorological events, like a cool, rainy summer occur.

The bill before this Subcommittee, House Resolution 980, is a reasonable and measured response to current concern over the possibility of climate change. By providing for the development of a national global change research plan, this bill coordinates and expedites continued research on climate change and other global environmental issues.

As someone who works at an oceanographic institution, I am particularly supportive of the clear role that this bill delineates for the National Oceanic and Atmospheric Administration in this endeavor.

By establishing the Council on Global Environmental Policy, this bill ensures that these issues receive the attention they deserve at a high level within the Government.

By amending the National Environmental Policy Act of 1969, to take into account impacts on the global environment, this bill recognizes the potential impacts of human activities on the global environment, and provides a means of monitoring and regulating these activities.

In conclusion, with regard to the climate change issue, we should heed the advice of Omar Bradley, and be guided by the stars, not by the lights of a passing ship.

The challenge evidently is to tell the two apart. The bill before this Subcommittee will help us meet that challenge. Again, thank you very much for giving me the opportunity to testify before this Subcommittee.

[The statement of Dr. Solow can be found at end of hearing.]

Mr. **Hertel**. Thank you very much, Doctor. Obviously the panel is in agreement with H.R. 980. There are many questions I want to ask of all of you. I would like to submit them in writing.

But whatever the degree of the effects that we are seeing, let me ask this question. Aside from land use, would all of the recommendations that people are coming forward with—even if we were wrong about what is occurring, or the rate of what might be occurring—after we have more information—are the other remedies aimed at pollution in any way, in general—aside from land use—and therefore, would these things make sense to do for the atmosphere, at any rate, even if we were not having the greenhouse effect? Dr. Solow.

Dr. **Solow**. Yes. I think they do, and I think that it is important to separate what the justifications are for different policy actions, and many of the same policy actions that people talk about being justified by the fears of climate change actually are justified for other reasons.

Mr. **Hertel**. Mr. Saxton.

Mr. **Saxton**. I am just curious as to how Dr. Schneider and Dr. Solow would characterize their seeming differences. I think Dr. Schneider originally indicated that the scientific community generally agrees that there is global warming taking place, and that the degree of increase in the temperature, perhaps, is the main difference, and what I got out of the second part of your testimony—I am sorry I missed the first part, Dr. Solow—was that you do not think that is necessarily true.

And frankly, I think if what I heard from you is true, in terms of what you said, you bring us great news. But am I reading the differences right?

Dr. **Solow**. The news is not that great. What I said is that if you look only at the historic record, that is, since measurements of temperature began in a serious way, at the end of the last century, until today, there are two things. One, there appears to be some evidence of slow irregular warming. I also said that, in my opinion—and I believe in the opinion of others—there is no clear evidence that any of that is due to changes in atmospheric composition.

That could be due to natural climate variability. So there has been some warming. What I also said is that in my own work—and again, I believe in the work of other people on this issue—no one has been able to detect an acceleration in that warming, that you might be able to say is due to the enhanced greenhouse effect.

Now, that does not say that there will not be such an acceleration, just that it has not happened yet, and no one could disagree with Dr. Schneider, that the greenhouse effect is real, and that the theory is a good theory, and that we should expect to see some warming coming out of the changes in atmospheric composition.

Mr. **Saxton**. Dr. Schneider, would you like to comment?

Dr. **Schneider**. Yes. I think the principal difference may really be one of emphasis. The problem is over the implications of the last century—I actually do not put a lot of stock in the last century. My concern over the future is based on physics. It is based on the well-validated principle of heat trapping that we all agree with.

The problem is, the climate system is a very noisy system, and there are all sorts of internal dynamics, as we say, that causes it to fluctuate. That makes it very hard to detect the signal of climate change out of the noise in a reliable way, except by waiting until you can prove it.

The problem with waiting, of course, is an experiment that we are performing in the one laboratory we have got, which is Earth, which always leads us back to the value question of whether to take that chance.

Let's consider that the half-degree warming, approximately—again, I do not know if it is a quarter, or three-quarters since the way we correct for temperature trends in the oceans is really of unknown accuracy. We do not know what way that will go.

Let's just buy the half degree for a minute. It is not necessarily inconsistent with the idea of greenhouse warming. It is just simply the probability at which you can believe it that is in doubt. There is no objective, easy way to assign probability to it. In my own personal view, I think it is connected to the increase in greenhouse gases this century. I do not know what the odds are. Three out of four, perhaps. I will be very surprised if we do not see a continuation of that trend in the next 10 to 20 years.

Based again, upon physics, I agree with Dr. Solow, that the connection is not established beyond reasonable doubt, but there is another question that we have to recognize. You do not validate the models on the basis of a half degree, or one degree kind of performance because it is still too close to the noise level.

There are so many other things that could have been happening this century, that could have accounted for either countervailing trends, or other ones. We do not know whether the sun was changing its energy output at the level of a few tenths of a percent over the past century.

If the sun had been decreasing its energy output on the order of a few tenths of a percent, that would have cut in half the response. That is a possibility. We do not know the extent to which human dust, in the northern hemisphere, may have held back those temperatures for a while, a regional phenomena, that eventually stopped increasing when we put on pollution controls in the 1970's.

It is simply impossible to assign statistical probabilities to this, and that is where the difference comes along. It is a matter of whether or not you want to take that chance by performing that experiment on this planet. But that is a value tradeoff. We are not debating the science so much, because the science says there has been a warming. It is impossible to ascribe it, you know, beyond a doubt, to greenhouse effect. It is consistently at the low end. That is all you can say.

Mr. SAXTON. Thank you. Permit me to just ask one final specific question about the bill—I do not know whether you have had a chance to look at it, or not—and I am prompted to ask this question by Ms. Moya, who indicated that perhaps 1 year was not enough time to put a study in place and make the recommendations as per the bill.

Section 204 of the bill indicates that there would be an annual report, and that the annual report would include activities of the council on global environmental policy during the preceding year, and, two, legislative and regulatory matters relating to global environmental change.

And then there would be a 5-year policy report which would include a report consisting of a comprehensive program to abate, mitigate, and adapt to the impacts of global environmental change. That is the thrust of the two types of reports. The question I have is, is that a good way to have this panel report, or, would you suggest that perhaps there ought to be a speed-up of recommendations, or a slowing down of recommendations? Just any one of the four who would like to comment maybe.

Ms. MOYA. I do not have a specific recommendation on that one. The policy people within the Chamber—let me backtrack. I staff the Chamber's Policy Committee on Energy. We have a corresponding committee on environment. Quite some time ago, when Senator Wirth and Senator Johnston had introduced their bills during the 100th Congress, and Claudine Schneider, on the House side, had introduced her bill—the business community recognized that this was a very important issue. We wanted to be proactive, provide as meaningful information as we could, keep ahead of the curve. That is why we are pleased to have the opportunity to testify.

It was a sub-group of these two committees, that serves as advisory group to me, in terms of responding to opportunities to testify. We have not addressed that specific question. I would be glad to provide that for the record, if that would be helpful to you.

One thing that was indicated by this advisory group was the fact that the 1 year time period allotted by the bill to submit the initial plan to Congress, that establishes this whole scheme, if you will, may be an inadequate time period, especially to allow meaningful comment by the public. History has sort of proved that 1 year goes by very, very rapidly, and that an additional six months or nine months may be in order, although we are not recommending any specific time horizon.

Mr. HERTEL. Why don't we do both? We could ask them to target a year, but then to go on with further recommendations, and get the flexibility in the language. I think it is a good point.

Ms. MOYA. Flexibility is terribly important, and we appreciate your having that in there.

Mr. HERTEL. We thank all of you. At this point in the record, the complete written testimony of Dr. Schneider and Dr. Solow will be submitted and any other further comments that you have can be added at your leisure.

I did want to mention that we have talked to the Navy a lot about this area of research regarding the national defense and we have got their attention. Now we just have to make them spend more money in this area. But I thank all of you for your testimony very much. It is very well-reasoned and educational. I am sorry more of the press is not here. If you were talking about the sky falling next month I am sure they would be, but I appreciate your trying to get the word out, very much, so that we can keep the public's attention in a rational way, and move the Congress forward in this direction. And as I say, the recommendations you have given us today, and additional ones that you might have, we can include in the substitute, and we are also going to be talking to the Ways and Means Committee about some of the tax incentives that Mr.

Slocum and you, Ms. Moya, talked about restoring, that were good ideas, good policy decisions in the past.

I think every other nation uses its tax policy for good direction and public purpose, and we used to until that last Tax Bill, and we are going to try to move ahead in those directions again. Thank you very much.

The last panel will be Dr. William E. Evans, Under Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration, Department of Commerce, and Dr. Dallas L. Peck, Director, United States Geological Survey, Department of the Interior. Dr. Evans.

STATEMENTS OF A PANEL, CONSISTING OF DR. ALAN R. THOMAS, ACTING ASSISTANT ADMINISTRATOR, OCEANIC AND ATMOSPHERIC RESEARCH, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, DEPARTMENT OF COMMERCE; AND DR. DALLAS L. PECK, DIRECTOR, UNITED STATES GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

Dr. THOMAS. Thank you, Mr. Chairman. Dr. Evans apologizes for having to cancel at the last minute. I am Dr. Alan R. Thomas, Acting Assistant Administrator for Oceanic and Atmospheric Research within NOAA, and it is within the Office of Oceanic and Atmospheric Research that NOAA's Climate and Global Change program is administered and managed.

Mr. HERTEL. Dr. Thomas, we will include Dr. Evans' statement in its entirety for the record, and we are glad to hear from you today.

Dr. THOMAS. Thank you very much. I would like to give a shortened version in the interest of time.

Thank you for the opportunity to discuss NOAA's programs in global change, and, in particular, the role of the oceans in climate change. NOAA's historic monitoring and prediction responsibilities lead naturally into an operational long-term view of the ocean, one which is critical to the development of a national program in global change research.

This is also consistent with NOAA's role as an environmental service, as described in the Statement to the Congress accompanying Reorganization Plan number four in 1980, which created NOAA. I quote a part of that statement:

"The oceans and atmosphere are interacting parts of the total environmental system upon which we depend not only for the quality of our lives but for life itself. We face immediate and compelling needs for a better understanding of the environment, an understanding which will enable us more effectively to monitor and predict its actions, and ultimately, perhaps, to exercise some degree of control over them."

NOAA's mission with respect to global change has been established within the context of the Committee on Earth Sciences, of the U.S. Global Change Research Program.

Dr. Peck will describe the Committee on Earth Sciences, and I will simply skip to the NOAA program.

The goal of the U.S. Global Change Research Program is to establish the scientific basis for national and international policy-making related to natural and human-induced changes in the global Earth system.

NOAA's current role in the research program, as endorsed by CES, will include the following: operational in situ and satellite observation and monitoring programs; research on physical and biochemical processes in the climate system, including their effects on marine ecosystems and resources; the development of models and diagnostic techniques for detecting and predicting natural and human-induced climatic changes; and the acquisition and maintenance of long-term data bases and related climate information.

NOAA's Climate and Global Change Program is the agency's focused contribution to the U.S. program. The central focus of the program is within the Office of Global Programs, which is responsible for coordinating the activities. An external panel of scientific advisors provides scientific input regarding for the program.

NOAA actively coordinates with other Federal agencies through CES and the Office of Management and Budget.

The Climate and Global Change Program is focused around four program elements: long-term observations, climate process studies, climate diagnostics and prediction, and climate data services.

Each of these elements incorporates an oceanic aspect. One of the major areas limiting our ability to ultimately predict global change is our lack of understanding of the role of the ocean in the exchange of heat, water, and trace gases with the atmosphere.

NOAA's ocean programs are designed to further our capacity to document and predict global change, and to project the impacts of this change on ocean resources. For these programs, a NOAA budget request for $20 million is included in the President's 1990 budget.

I would like to describe NOAA's research activities related to the role of the oceans in global change.

Given that the upper three meters of the ocean alone can hold as much heat as the entire atmosphere, understanding the role of the ocean clearly is important to understanding climate variability over a number of years. In the tropical Pacific, a large-scale network for upper ocean thermal structure, sea level, and surface winds monitors the evolution of El Nino events.

In addition, the environmental satellites operated by NOAA play a key role in monitoring quantities such as global sea surface temperature. We foresee significant expansion of our ocean observing network beyond the tropics as guided by the informational needs of emerging ocean models.

These models have demonstrated the ability to assimilate large volumes of ocean data in the most effective manner possible. Sea level measurements have an important place in the ocean-observing system, since the time series of rising sea level is one of the most prominent data sets which have alerted scientists and the public to global change.

NOAA will continue to install a global sea level network to provide accurate measurements of absolute sea level. On global scales, NOAA's use of the Navy GEOSAT satellite altimeter has resulted in the operational production of monthly maps of relative sea level over entire ocean basins.

Predictive modeling of the coupled ocean-atmosphere system clearly requires a better understanding of the way heat and trace gases are exchanged across the ocean-atmosphere boundary.

Our knowledge of ocean circulation is far less advanced than our understanding of atmospheric circulation. For this reason, NOAA and other Federal agencies support and participate in the World Ocean Circulation Experiment, a multi-year international effort to better define the circulation of the global ocean.

In biogeochemical cycling of climatically important gases, our lack of knowledge of the ocean's physical and biochemical control over levels of atmospheric trace gases limits our ability to reliably predict future climate.

Preliminary estimates suggest that 40 percent of the annual release of fossil fuel CO_2 is absorbed by the oceans. While we recognize that the world's oceans regulate the degree to which CO_2 has increased in the atmosphere, there is no consistent time series measurements of oceanic CO_2 to parallel the atmospheric record.

Only an understanding of the important pathways, fluxes, and storage of carbon in the ocean will allow a reliable prediction of the long-term climatic impact of fossil fuel combustion and efforts to mitigate the effects of such combustion.

Recent research also has indicated that the ocean may influence climate through the formation of clouds. The major source of cloud condensation nuclei over the ocean is a sulfur compound produced by phytoplankton which forms an aerosol in the atmosphere.

Among potential climate effects that influence fisheries are sea level rise, which could have a potentially significant effect on critical fishery habitats, including estuaries and associated wetlands; changes in ocean temperature and circulation, which could have effects on the distribution and relative abundance of fisheries stocks; and, finally, increases in ultraviolet radiation as a result of ozone depletion, which could lead to a higher risk of potentially lethal exposure to pelagic fish eggs and to phytoplankton and bacteria on which fish feed.

One of our principal reasons for optimism in the pursuit of long-term climate prediction is the progress which has been made in understanding the role of the equatorial ocean in the interannual climate change as a result of the Tropical Ocean Global Atmosphere Program, which NOAA manages.

This is an international program that seeks to understand the evolution of the El Nino phenomena.

TOGA research has provided insights into climate variability beyond the tropics also. Recent findings suggest that the cold water in the equatorial Pacific following the 1987 El Nino played a prominent role in the North American drought of 1988. Diagnostic studies suggest that a ridge of high pressure over the American Midwest was linked by an atmospheric wave train to the tropical Pacific, somewhat like a boulder in a river causing ripples downstream. Unraveling the progression of such climatic events is one of the keys to development of predictive skill.

Developing a climate prediction capability will require substantially improving our ability to model the ocean and atmosphere and assimilate data from ocean monitoring systems.

NOAA, through its Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey, and the National Meteorological Center, pursues a vigorous modeling strategy developing oceanic, atmospheric, and coupled ocean-atmosphere models.

To strengthen that modeling capability, we are requesting funds in fiscal year 1990 to obtain seventh generation supercomputers for ocean modeling research, and other purposes, at the Geophysical Fluid Dynamics Laboratory, and for operational purposes at the National Meteorological Center.

NOAA is responsible for the compilation and maintenance of consistent high-quality data sets of marine observations which have been collected across the globe since the 1960's.

Much of our current knowledge of climate change and climate variations has been gleaned from oceanic data. NOAA has taken a first step toward producing a consistent data base of marine observations through the development of a Comprehensive Ocean-Atmosphere Data Set. We are also actively supporting a newly-formed Interagency Working Group on Data Management for Global Change.

The goal is a national data and information system for global change research by 1995, that is consistent across agencies, and involves and supports the university and other user communities.

Finally, I would like to make just a couple of comments with regard to H.R. 980. The full text of the comments are in Dr. Evans's prepared statement.

In this regard, we support the concepts of a national global change research plan as described in Title I of the bill. We must point out that the Administration is actively pursuing the implementation of such a Government-wide research plan under existing authorities.

If the Congress enacts the bill, we believe that certain changes would be desirable, to reflect the current scientific uncertainties in our ability to predict climate change.

A second would be to ensure consistency within the existing Federal structure for global change research. And finally, to reflect the statements of present agency roles which were developed and approved by the CES as part of the initial research plan for the U.S. Global Change Research Program. That concludes my testimony, Mr. Chairman.

[The statement of Dr. Evans can be found at end of hearing.]

Mr. HERTEL. Thank you, Doctor. I appreciate, even though you are announcing opposition to 980 in the statement, that you have recommendations to improve the bill. I appreciate that very much.

I have one question for you to answer, in writing, and some other additional ones. But the one I want to mention is that Dr. Evans' statement talks about opposing enactment of H.R. 980 for the reasons listed. But the Department of Commerce has issued a statement in support of S.169, the Hollings Bill, which is virtually identical to Title I of H.R. 980.

So we would like the Department to answer that for us, in writing, what their discrepancy is in that regard.

Dr. THOMAS. We will do that.

[The information follows.]

The Department does support the objectives of Title I of H.R. 980 to develop a National global change research plan, which is similar to S. 169, the Hollings Bill, which the Department supports. However, the Administration opposes Title III of H.R. 980, which appears unnecessary because its substance can be implemented under the current authority of NEPA. Thus, the Administration does not support H.R. 980 due to the duplicative nature of some of its provisions.

As stated in Dr. Evans' written testimony, NOAA would like to suggest changes which reflect current scientific uncertainty concerning global change and ensure greater consistency with the existing Federal structure for global change research, i.e. the U.S. Global Change Research Program.

> The Finds section should be amended to reflect the current scientific uncertainty in our ability to predict global climate change.
>
> Section 102(a)(4) should read: Development of effective policies to abate and mitigate human-induced and natural global changes will depend on our ability to understand global environmental processes, predict global environmental changes, and distinguish between the effects of human activities and the results of natural change.
>
> Proposed sections 101(b)(4) and 101(c) should include the Departments of State, Agriculture, and Transportation in the listing of agencies whose programs and activities must be addressed and considered by the Plan since they are currently members of the Committee on Earth Sciences and are helping to develop the initial research plan for the U.S. Global Change Research Program.
>
> Proposed section 101(c) should reflect the statements of agency roles developed and approved by CES in their initial research plan for the U.S. Global Change Research Program.

Mr. HERTEL. Thank you. Dr. Peck.

STATEMENT OF DR. PECK

Dr. PECK. Good afternoon, Mr. Chairman. It is a pleasure to be here to testify. I am testifying on behalf of the Federal Coordinating Council's Science, Engineering, and Technology Committee on Earth Sciences, and so I am testifying, not as a director of the Geological Survey, but as Chairman of that Committee on Earth Sciences.

I would like to submit my testimony for the record, if I may, and summarize it. I would also like to submit for the record Dr. Corell's testimony, approved by the Administration, before the Committee on Earth Sciences on Senate Bill 169, which is fairly similar to Title I of your bill.

I certainly agree with the concern evident in your Committee, and elsewhere, about global change. I just came from spending two days at a forum on global change and our common future, a forum organized by the National Academy of Sciences, the National Science Foundation, the Smithsonian, and other organizations.

It had to be moved from the academy to the National Theater in order to accommodate the anticipated attendants, and all the seats were filled. It was an excellent summary of our current knowledge of the situation.

For me, there is a larger problem than the ones we are used to dealing with, both on possible impacts, the global scale of the problem, the interdisciplinary emphasis, and the bureaucratic scale—the fact that so many different agencies are involved.

You asked me to testify about three issues today—one, climate change itself, two, the role of the Committee on Earth Sciences, and three, my reaction to H.R. 980, particularly Title I.

As to the first issue, I think that was covered very well by Drs. Schneider and Solow, but I would like to emphasize a couple points. One, that some things are very certain. That is, that greenhouse gases are going up, and that is a worrisome matter.

Another is that our understanding of the world climate is very uncertain, and the effect of those increasing trace gases in the atmosphere, our understanding of that is very uncertain.

Another is that Earth history has been very dynamic, and the natural variability of the climate is considerable. Over the last 20,000 years, without any interference by mankind, temperatures have been as much as 5° less and as much as 2° more. At 5° less, we are in the heighth of the ice ages. In the very short term there has been probably warming, as was discussed by the previous speakers, of about a half a degree, over the last 100 years, but it is certainly unclear whether that warming is due to natural variability in the coming out of the "little ice age," or whether it is related to the greenhouse effect and trace gases in the atmosphere.

I will say I am optimistic that we are going to make a lot of progress on this matter over the next couple years. We have a number of new tools, and particularly the satellites operated by our colleagues in NOAA, new, powerful computers, and a better understanding of various aspects of the problem, including El Nino.

We also have better organizational links, now, to address the problem. The World Climate Research Program run by the World Meteorological Organization and the UNEP. The International Geosphere-Biosphere Program. Our own Committee on Earth Sciences which I am representing today, and, the National Research Council's Global Change Committee.

We also are starting to work more effectively across discipline lines, and that is going to mean an essential part of this program because it involves both the biological, the physical, the mathematical and the sociological sciences.

Just the categories themselves indicate a number of disciplines. We break it into seven categories, and the first is biogeochemical fluxes. So, you have got quite a bit right there. As far as the second issue, and that is the Committee on Earth Sciences and its role, I will say we have, I think, made a lot of progress in the last several years, and the committee is operating in a very similar manner to that as outlined in the bill.

It was established about two and a half years ago. I have been Chairman for going on 2 years, and we have made a lot of progress. A large number of agencies are represented, somewhat more than are listed in the bill, but we can discuss that later.

We have been particularly effective in working very closely with the Office of Management and Budget, and that is a unique experience for some of us, and I think has been very profitable for the program.

We put out a strategy document that was included with both the Bush and the Reagan budget called Our Changing Planet: A U.S. Strategy For Global Change Research, and I would like to submit that for the record. That outlines the strategy for the program. We are working, and well along on a research plan which lays out what needs to be done to better understand the whole issue. That is well along. We hope to have it completed within the next month or so, and, before too long, should be able to share it with the Congress.

That research plan will identify the strengths and weaknesses of current programs, and connect new initiatives to gaps in our understanding. It is a living document, and we anticipate that we will be revising it every year. We have shared it with the National Academy of Sciences, and we are going to be meeting next Monday to go over their comments on that document, and we plan to continue to share that with the science community through the year, and through the years, so that it continues to be updated and to reflect our understanding of the scientific issues involved.

There is a strong tie to the international program, and it is important to emphasize this is a global program. It is going to take global participation in understanding what is going on. It is going to take global participation in counteracting any possible effects of climate change. And there is a strong interaction both with the International Geosphere-Biosphere Program, the World Climate Research Program, and the Intergovernmental Panel on Climate Change, of which there are three panels, one on research, that our committee is working with very closely.

As far as our attitude towards the Global Environmental Research and Policy Act of 1989, by and large, we do support Title I, as we supported Senate Bill 169. We have prepared some consensus agency role statements of which we are very proud, and we would like to share those with your staff, and see about incorporating those, or something like that in the bill.

We have some difficulties with other parts of that Title I, but, again, we would like to work with your staff towards that regards, and that is the end of my statement.

[The statement of Dr. Peck can be found at end of hearing.]

Mr. **Hertel**. Well, Doctor, we look forward to working with you on your ideas in regard to 980, and appreciate all the work that you have done for the Committee on Earth Sciences, as its director, very much. We will have some other questions for you, in writing, also, and we thank you very much for all of your good work and time today.

Dr. **Peck**. Thank you.

Mr. **Hertel**. Thank you, Dr. Thomas.

The hearing is adjourned.

[Whereupon, at 1:07 p.m., the Subcommittee was adjourned, subject to the call of the Chair.]

[The following was submitted for the record.]

I

101st CONGRESS
1st Session

H. R. 980

To provide for development of a National Global Change Research Plan to coordinate oceanographic, atmospheric, terrestrial, and polar research programs; to establish the Council on Global Environmental Policy; and to amend the National Environmental Policy Act of 1969 to require consideration of the impact of major Federal actions on the global environment.

IN THE HOUSE OF REPRESENTATIVES

February 9, 1989

Mr. Jones of North Carolina (for himself, Mr. Studds, Ms. Schneider, Mr. Hertel, Mr. Lent, Mr. Miller of California, Mr. Hughes, Mr. Foglietta, Mr. Tauzin, and Mr. Carper) introduced the following bill; which was referred jointly to the Committees on Science, Space, and Technology, Merchant Marine and Fisheries, and Interior and Insular Affairs

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A BILL

To provide for development of a National Global Change Research Plan to coordinate oceanographic, atmospheric, terrestrial, and polar research programs; to establish the Council on Global Environmental Policy; and to amend the National Environmental Policy Act of 1969 to require consideration of the impact of major Federal actions on the global environment.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Global Environment Research and Policy Act of 1989".

SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress finds and declares the following:

(1) There exists compelling scientific evidence that the climate is warming and the sea level is rising on a global scale.

(2) Industrial, agricultural, and other human activities, coupled with an expanding world population, are contributing to processes of global change that may significantly alter the global ecosystem within a few generations.

(3) Such human-induced changes may lead to significant global warming and thus alter world climate patterns and increase global sea levels. Over the next century, these consequences could adversely affect world agricultural and marine production, coastal habitability, global economic and social well-being, human health, and biological diversity.

(4) Development of effective policies to abate, mitigate, and adapt to human-induced and natural global changes will depend on our ability to understand global environmental processes, predict global environ-

mental changes, and distinguish between the effects of human activities and the results of natural change.

(5) New developments in interdisciplinary Earth sciences, global observation systems, and computer technology make possible significant advances in the scientific understanding and prediction of these global changes and their effects.

(6) Several Federal agencies are conducting activities which could contribute to a well-defined and coordinated national program of research, monitoring, assessment, information management, and prediction.

(7) The United States should provide leadership in developing and implementing an international global change research program.

(b) PURPOSES.—The purposes of this Act are—

(1) to provide for a national research plan which, when implemented, will assist understanding, assessing, predicting, and responding to human-induced and natural processes of global change; and

(2) to establish the Council on Global Environmental Policy to coordinate development of national policies to abate, mitigate, and adapt to the impact of global environmental change.

TITLE I—NATIONAL GLOBAL CHANGE RESEARCH PLAN

SEC. 101. DEVELOPMENT OF NATIONAL GLOBAL CHANGE RESEARCH PLAN.

(a) IN GENERAL.—The Federal Coordinating Council on Science, Engineering, and Technology shall develop a plan, to be known as the "National Global Change Research Plan", for a 10-year program of national research on processes and factors which contribute to global environmental change, including research on increases of global sea levels.

(b) CONTENTS OF PLAN.—The Plan shall—

(1) identify goals, priorities, and approaches for global change research conducted or funded by the Federal Government which most effectively—

(A) advance scientific understanding of global change; and

(B) provide a basis for policy decisions relating to global change;

(2) describe the specific role of each Federal agency in implementing the Plan;

(3) recommend allocations of Federal funding among specific research activities to achieve goals and priorities identified by the Plan, including data collection and analysis, process studies, predictive modeling,

participation in international research efforts, and information management;

(4) provide for identification and coordination of the relevant programs and activities of—

(A) the Department of Commerce, particularly the National Oceanic and Atmospheric Administration;

(B) the National Science Foundation;

(C) the National Aeronautics and Space Administration;

(D) the Department of the Interior, particularly the United States Geological Survey;

(E) the Department of Energy;

(F) the Department of Agriculture;

(G) the Environmental Protection Agency;

(H) the Department of Defense, particularly the Department of the Navy; and

(I) other agencies of the United States the Chairman of the Council considers appropriate;

(5) describe specific research and other activities to be conducted under the Plan, including—

(A) global measurements necessary to document global change;

(B) studies to understand the physical, chemical, and biological processes responsible for changes in the Earth system on all time scales;

(C) development of quantitative models of the Earth system to simulate system dynamics and to allow identification and prediction of global environmental trends; and

(D) development of an information base, including necessary management systems which will support effective decision making;

(6) incorporate and coordinate appropriate research activities conducted under the National Sea Grant College Program Act (33 U.S.C. 1121 et seq.) as integral components of national global change research activities conducted under the Plan; and

(7) coordinate the global change research activities of the United States with programs of other nations and international agencies and organizations, including the World Meteorological Organization and the United Nations Environmental Program.

(c) ALLOCATION OF RESEARCH RESPONSIBILITIES AMONG FEDERAL AGENCIES.—In addition to providing for the matters set forth in subsection (b), the Plan shall allocate among Federal agencies responsibilities to perform research under the Plan in accordance with existing and appropriate additional agency missions and responsibilities, including—

(1) allocating to the National Oceanic and Atmospheric Administration the responsibility for: operational environmental satellite programs; observation, research, predictive modeling, and data management programs for ocean and atmospheric processes; climate diagnostics and prediction; ecosystem diagnostics and prediction, focusing primarily on living resource dynamics; documentation and prediction of sea level rise and associated effects on coastal communities; accelerated development and application of predictive models and techniques for detecting natural and human-induced changes; acquisition, maintenance, and distribution of long-term data bases; calibration and validation of environmental observations; processing and archiving of space-based and earth-based data; and development and support of operational ground-based oceanic and atmospheric monitoring systems;

(2) allocating to the National Science Foundation the responsibility for basic research in the areas of: Earth, atmospheric, and ocean science, including biological sciences; ground-based measurements for regional and global studies; polar studies; large-scale field programs; interpretation and use of space-based

data; theoretical and laboratory studies; research facilities support; and development of numerical models, information and communication systems, and data bases;

(3) allocating to the National Aeronautics and Space Administration primary responsibility for: Earth science research missions from space (including those of broad scientific scope) to study the Earth as an integrated system, including associated efforts related to ground studies; remote-sensing and advanced instrument development; improvement of techniques for the transmission, processing, archiving, retrieval, and use of data and related models; and other research activities; and

(4) allocating to the United States Geological Survey primary responsibility for: geological studies and mapping, including paleoclimate and hydrologic cycle studies; geographical information systems; management of land remote-sensing data; and acquisition, maintenance, and distribution of long-term data bases for these areas.

(d) USE OF REPORTS AND STUDIES IN DEVELOPING PLAN.—In developing the Plan, the Federal Coordinating Council shall consider and use, as appropriate, reports and studies conducted by Federal agencies, the National Research Council, and other entities.

(e) SUBMISSION TO CONGRESS.—The Federal Coordinating Council shall submit the Plan to the Congress not later than one year after the date of enactment of this Act.

(f) REVISION OF PLAN.—The Federal Coordinating Council shall revise the Plan at least once every 3 years and shall submit each revised Plan to the Congress not later than the end of each 3-year period.

SEC. 102. IMPLEMENTATION OF PLAN.

(a) IMPLEMENTATION BY FEDERAL COORDINATING COUNCIL.—The Federal Coordinating Council shall—

(1) oversee implementation of the Plan;

(2) coordinate global change research activities among Federal agencies and report annually to the President and the Congress, through the Chairman, on any recommended changes in agency roles that are needed to better implement the Plan;

(3) work with the National Research Council and with academic, State, and other groups conducting research and assessments of global change and its effect;

(4) coordinate Federal interagency participation in international activities related to global change research and assessments; and

(5) consult with users of information systems to promote consistent, efficient, and compatible transfer

and use of data obtained from research conducted under the Plan.

(b) COOPERATION WITH SECRETARY OF STATE.—The Chairman and the Secretary of State shall cooperate in providing representation at international governmental meetings and conferences on global change in which the United States participates.

SEC. 103. BUDGET COORDINATION.

(a) SUBMISSION OF REPORTS WITH AGENCY APPROPRIATIONS REQUESTS.—

(1) IN GENERAL.—Each Federal agency involved in global change research shall include with its annual request for appropriations submitted to the President under section 1108 of title 31, United States Code, a report identifying each element of its proposed global change activities which—

(A) specifies whether each element—

(i) contributes primarily to the implementation of the Plan; or

(ii) contributes primarily to the achievement of other objectives but aids Plan implementation in important ways; and

(B) states the portion of its request for appropriations that is allocated to each element.

(2) SUBMISSION OF AGENCY REPORTS TO FEDERAL COORDINATING COUNCIL.—Each agency which submits a report under paragraph (1) shall submit that report simultaneously to the Federal Coordinating Council.

(b) CONSIDERATION OF PLAN IN PRESIDENT'S BUDGET.—

(1) REVIEW OF AGENCY BUDGET ESTIMATES BY COUNCIL.—Before submitting each annual budget to the Congress under section 1105 of title 31, United States Code, the President—

(A) shall provide to the Federal Coordinating Council an opportunity to review and comment on the budget estimate for each agency in the context of the Plan; and

(B) shall make the results of that review and comments available to each agency and to the appropriate elements of the Executive Office of the President, particularly the Office of Management and Budget.

(2) IDENTIFICATION OF ALLOCATIONS FOR GLOBAL CHANGE ACTIVITIES.—The President shall identify in each annual budget submitted to the Congress under section 1105 of title 31, United States Code, the portion of each agency's annual budget that

is allocated to each element of that agency's global change activities.

SEC. 104. REPORTS.

(a) IN GENERAL.—The Chairman shall prepare and submit to the President and the Congress, at the time of submission of the Plan to the Congress pursuant to section 101(e) and at the time of submission of each revised plan pursuant to section 101(f), a report on the activities conducted by the Federal Coordinating Council under this Act during the period covered by the report, including—

(1) a summary of the achievements of Federal global change research efforts during the period covered by the report and priorities for future research;

(2) an analysis of the progress made toward achieving the goals and objectives of the Plan;

(3) a copy or summary of the Plan and any changes made in the Plan;

(4) a summary of agency budgets for global change activities for the preceding fiscal years; and

(5) any recommendations regarding additional action or legislation which may be required to assist in achieving the purposes of this Act.

(b) FINAL REPORT.—Upon completion of research under the Plan, the Chairman shall prepare and submit to the President and the Congress a final report on—

(1) the matters described in subsection (a);

(2) the extent to which the objectives of the Plan have been achieved; and

(3) recommendations for additional research in furtherance of the Plan.

TITLE II—COUNCIL ON GLOBAL ENVIRONMENTAL POLICY

SEC. 201. ESTABLISHMENT OF COUNCIL ON GLOBAL ENVIRONMENTAL POLICY.

There is established in the Executive Office of the President the Council on Global Environmental Policy.

SEC. 202. MEMBERSHIP OF COUNCIL.

(a) In General.—The Council on Global Environmental Policy shall be composed of 11 members as follows:

(1) The Director of the Office of Science and Technology Policy.

(2) The Chairman of the Council on Environmental Quality.

(3) A representative of each of the following agencies appointed by the head of each respective agency:

(A) The Department of Commerce.

(B) The Department of Energy.

(C) The Department of Agriculture.

(D) The Department of the Treasury.

(E) The Department of the Interior.

(F) The Department of State.

(G) The Department of Transportation.

(H) The Environmental Protection Agency.

(I) The Federal Emergency Management Agency.

(b) CHAIRMAN.—The Chairman of the Council on Environmental Quality shall serve as Chairman of the Council on Global Environmental Policy.

SEC. 203. FUNCTIONS OF COUNCIL.

The Council on Global Environmental Policy shall advise the President regarding domestic and international policies, plans, and programs of the Federal Government related to global environmental change. In carrying out its functions under this section, the Council on Global Environmental Policy shall—

(1) recommend approaches for coordinating programs, plans, and policies of Federal and State agencies to abate, mitigate, and adapt to the impacts of global environmental change;

(2) make use of the scientific findings and recommendations that result from implementation of the Plan;

(3) recommend to the Federal Coordinating Council the research goals, priorities, and approaches which

most effectively provide a basis for policy decisions related to global environmental change;

(4) initiate and coordinate studies funded or conducted by the Federal Government relating to the economic and social impacts of global environmental change; and

(5) collect and analyze data and information on social, economic, and environmental impacts of global environmental change and related policy.

SEC. 204. REPORTS.

(a) ANNUAL REPORT.—The Council on Global Environmental Policy shall report annually to the Congress and the President regarding—

(1) activities of the Council on Global Environmental Policy during the preceding year; and

(2) legislative and regulatory matters relating to global environmental change.

(b) FIVE-YEAR POLICY REPORT.—Not later than 5 years after the date of the enactment of this Act, the Council on Global Environmental Policy shall develop and submit to the Congress and the President a national global environmental policy report consisting of a comprehensive program to abate, mitigate, and adapt to the impacts of global environmental change. The council shall thereafter periodically revise and update the report to incorporate the results of research conducted under the Plan.

TITLE III—MISCELLANEOUS

SEC. 301. IMPACT OF MAJOR FEDERAL ACTIONS ON GLOBAL ENVIRONMENT.

Clause (i) of section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)(i)) is amended by inserting "including the impact on the oceans, the atmosphere, and other aspects of the global environment," after "proposed action,".

SEC. 302. DEFINITIONS.

In this Act—

(1) the term "Federal Coordinating Council" means the Federal Coordinating Council on Science, Engineering, and Technology, established by section 5 of Executive Order 12039 (42 U.S.C. 6601 note);

(2) the term "Plan" means the National Global Change Research Plan developed under section 101; and

(3) the term "Chairman" means the chairman of the Federal Coordinating Council.

DEPARTMENT OF DEFENSE
OFFICE OF GENERAL COUNSEL
WASHINGTON, D.C. 20301-1600

7 JUL 1989

Honorable Walter B. Jones
Chairman, Committee on Merchant
Marine and Fisheries
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

This is in response to your request for the views of the Department of Defense (DoD) on H.R. 980, 101st Congress, "To provide for development of a National Global Change Research Plan to coordinate oceanographic, atmospheric, terrestrial, and polar research programs; to establish the Council on Global Environmental Policy; and to amend the National Environmental Policy Act of 1969 to require consideration of the impact of major Federal actions on the global environment."

We have examined H.R. 980 as it relates to the Department of Defense role in global change and to insure that national and defense concerns are addressed.

The Department of Defense believes the establishment of the Council on Global Environmental Quality in title II of the bill is duplicative of the function of the Council on Environmental Quality. If, however, this Council is created, it should include Department of Defense participation. While we do not have a leading role in the specific objective of understanding how the environment is being affected, we have an obligation to understand how global changes will affect defense interests. This extends to understanding how regulatory or planning actions that are designed to address, understand, or mitigate global effects may affect defense activities or our abilities to carry out our mission.

We object to the provisions of title III, section 301, "Impact of Major Federal Actions on Global Environment," amending the National Environmental Policy Act of 1969 (NEPA). The broad scope of this amendment could be interpreted to extend NEPA requirements to cover Federal actions outside the United States and its territories. Treaty obligations and the sovereignty of other nations conflict with this broad scope. Executive Order 12114, entitled "Environmental Effects of Major Federal Actions Abroad," enables decision-makers in Federal agencies to consider environmental effects when authorizing and and approving activities which would significantly affect the environment outside the United States. Since this is the apparent intent of the proposed amendment, its inclusion appears unnecessary as well as to create a potential area of political conflict.

The Office of Management and Budget advises that there is no objection to the submission of this report for the consideration of the committee.

Sincerely,

L Niederlehner

L. Niederlehner
Deputy General Counsel

ONE HUNDRED FIRST CONGRESS

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U.S. House of Representatives
Committee on
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MINORITY CHIEF COUNSEL
DUNCAN C SMITH III

BACKGROUND MEMORANDUM

TO: Members
Subcommittee on Oceanography and the Great Lakes

FROM: Committee Staff

DATE: May 2, 1989

SUBJECT: Global Climate Change Hearing

On Thursday, May 4, 1989, at 11:00 a.m., in Room 1334 Longworth House Office Building, the Subcommittee on Oceanography and the Great Lakes will conduct a hearing on global climate change. Testifying at the hearing will be representatives of the environmental community, the scientific community, industry and the Federal Government.

BACKGROUND

Weather always has been unpredictable, but more an inconvenience than a threat. This changed during 1988. Public attention spawned by the severe summer drought across the United States was unparalleled since the Dust Bowl of the 1930s. The specific cause of this drought remains uncertain but it clearly heightened national concern about a trend to which many scientists have been pointing for over a decade -- long term increases in average global temperature.

The Greenhouse Effect. The words "greenhouse effect" have, practically overnight, become synonymous with environmental disaster on a global scale. Ironically, it is the greenhouse effect which makes Planet Earth hospitable in the first place.

Essential to the habitability of the Earth is its enveloping blanket of air. The Earth's atmosphere is relatively transparent to incoming sunlight which warms the planet's surface. However, when the planet gives off its excess heat, it does so, not with visible light, but with infrared radiation. The so-called "greenhouse gases" like carbon dioxide, methane, chloroflorocarbons (CFCs), ground-level ozone, and nitrous oxide absorb some of this excess heat, trapping it in the lower atmosphere (see Figure 1). The net result is an equilibrium, where temperatures at the Earth's surface are maintained at a level warmer than those which the Earth would otherwise experience if there were no intervening atmosphere. Without a heat-trapping atmosphere, the planet would have an average surface temperature as low as -4 degrees Fahrenheit, instead of the current average of 59 degrees Fahrenheit.

The problem is this: since the Industrial Revolution began in the early 1800s, human activities have been releasing enormous quantities of greenhouse gases into the atmosphere. Since the heat-trapping effect of these gases is additive, their buildup in the atmosphere is expected to cause long-term increases in average global temperatures. The natural equilibrium is being disrupted.

Carbon dioxide is the major contributor to the greenhouse effect, providing roughly 50 percent of the atmosphere's heat-trapping capacity. It is a natural constituent of the Earth's atmosphere. However, atmospheric carbon dioxide concentrations have risen dramatically due to emissions from the burning of fossil fuels (e.g., coal, oil, and natural gas) in automobiles, power plants, industries, and homes. Since the beginning of the Industrial Revolution, atmospheric concentrations of carbon dioxide have risen by 25 percent.

Concentrations of other greenhouse gases are also increasing. Collectively, methane, CFCs, ground-level ozone and nitrous oxide contribute about as much as carbon dioxide to the greenhouse effect (see Table 1). Except for CFCs, these gases are also natural atmospheric constituents and are also linked, in varying degrees, to the burning of fossil fuels. Ground-level ozone, for instance, is a major constituent of urban smog and is derived principally from automobile emissions; methane, however, is a primary product of "natural" organic decomposition processes and agriculture is a major source.

Finally, the greenhouse contribution of ground-level (or trophospheric) ozone should be distinguished from the "shielding effect" of upper-atmospheric (or stratospheric) ozone. In the upper atmosphere, naturally occurring ozone shields the planet from harmful, ultraviolet radiation. In the lower atmosphere, ozone is a product of human activity and contributes to the greenhouse effect.

Predicting Global Climate. Estimating accurately the climatic effect of continued greenhouse gas emissions requires two things: predictions of future emissions and quantitative models of the climate system. Currently, it is expected that before the middle of the next century, the combined effect on increases in all greenhouse gases will produce an impact on the climate roughly equivalent to a doubling of preindustrial levels of carbon dioxide alone. Based on this assumption, numerical models of the climate system indicate that long-term global average temperatures will increase between 2-9 degrees Fahrenheit. As a point of comparison, average temperatures during the Ice Age 18,000 years ago were only about 9 degrees Fahrenheit colder than now.

The precision of these estimates is called into question by our limited understanding of the natural processes which drive global climate. Clouds, for instance, cover 60 percent of the planet and generally serve to reflect sunlight back into space before it reaches the Earth's surface. Current climate models assume that greenhouse gases will thin cloud coverage, increasing temperatures further. However, it is also possible that greenhouse gases will produce more clouds, and thus, cool the Earth.

The role of the oceans is also poorly understood, although generally recognized as a major factor in driving global climate. The oceans have a large capacity for soaking heat and carbon dioxide from the atmosphere; thus, the ocean is expected to ameliorate global climate increases. However, as the ocean gradually warms, its ability to absorb carbon dioxide will decrease and atmospheric concentrations will grow even faster. Furthermore, the rate at which the ocean takes heat from the atmosphere will also decrease. Our knowledge of global ocean processes and absorptive capacities is so limited that there is uncertainty as to their overall influence on climate change:

> "I can paint you scenarios in which the oceans make the greenhouse effect worse and others in which they delay it."
>
> Dr. Carl Wunsch
> Massachusetts Institute of Technology

The observed temperature record since the onset of the Industrial Revolution provides another opportunity to evaluate the climatic effect of greenhouse gas buildups. Over the last 100 years, mean global temperature has risen approximately 0.4 degrees Celsius. However, there is disagreement between leading scientists whether these observed temperature increases signal that a greenhouse-induced global warming has begun.

In summary, it is generally safe to conclude that the greenhouse effect is a very well established and accepted scientific theory. There appears to be strong scientific consensus that global warming, through acceleration of the greenhouse effect, is highly probable if the currently heavy worldwide reliance on fossil fuels continues. **What is controversial is exactly how much, and at what rate, global temperature will rise given a certain increase in concentration of greenhouse gases, and whether recent meteorological events are related to the observed buildup of greenhouse gases.** Despite the extensive work to date, many uncertainties remain about both the timing and the extent of global climate change.

__Effects of Global Climate Change.__ Notwithstanding these uncertainties, we are confronted with the very real possibility that human activity is changing the earth system in a way that will dramatically affect the global environment. If current predictions prove accurate, we will see worldwide changes in many features of the hydrological cycle, with consequences for soil moisture, river flow, glacial extent, and the distribution of crop zones, and fisheries and wildlife populations. In addition, there are reasons to expect that warmer ocean temperatures will lead to more violent tropical storms. Such changes could have widespread and complex environmental and economic impacts:

* Climatic zones and storm tracks may shift toward the poles. Crop zones and ecosystems can be expected to migrate with the changing climate. Extinction of some species may occur or be accelerated.

* Melting glaciers and thermal expansion of sea water are expected to raise global sea levels significantly over the next century; reasonable estimates center on a one meter rise. This will increase coastal erosion, wetlands loss, saltwater intrusion, and distribution of marine species.

* Warmer ocean temperatures may increase the severity and frequency of hurricanes which draw their energy from warm ocean water. The combination of increased sea level and "super hurricanes" could be disastrous for coastal communities.

* Warming is expected to be considerably greater in polar latitudes than in the tropics, and sea ice would diminish. A navigable Arctic Ocean would have major national security implications.

* Changes in rainfall patterns are likely.

GLOBAL WARMING: THE RESPONSE

The industrialization of the planet in the 19th and 20th centuries has given rise to a concern that human activity may be adversely affecting the earth system in a way which will alter global habitability. At the same time, science and technology have evolved sufficiently to begin to unravel the complex processes that drive the earth system, including how human activities may influence them.

The difficult challenge to policy makers is how to respond to such a supreme threat when the only evidence is a scientific theory, the prediction of computer models, and observation of a slight warming over the past century (of which the latter two are beset by troubling uncertainties). If one gives any credence to current predictions, then it is clear that some action is essential. Waiting for certainty could well commit us to climate changes at a rate and extent which are unprecedented, and with social and environmental consequences which are unacceptable.

Research. In January, 1988, the Earth System Sciences Committee of the NASA Advisory Council issued a report recommending development of a coordinated Federal Government program in global change research. This report identified three federal agencies as pivotal to this program: NASA; the National Science Foundation (NSF); and the National Oceanic and Atmospheric Administration (NOAA). In January, 1989, the Committee on Earth Sciences (CES) of the Federal Coordinating Council for Science, Engineering, and Technology, issued a document entitled "Our Changing Planet: A U.S. Strategy for Global Change Research". This report accompanied the President's Fiscal Year 1990 budget and recommends a $190.5 million research program involving seven federal agencies (see Table 2). Nonetheless, some have criticized this funding level as inadequate; the Climate Institute, for example, maintains that an additional $170 million is necessary.

International Coordination. International efforts are underway to coordinate efforts in response to the potential for global climate change. Notable among them is formation of the Intergovernmental Panel on Climate Change (IPCC), a joint effort of the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The IPCC has established three working groups: Group I (science); Group II (environmental and socio-economic impacts); and Group III (response strategies). The United States is the designated chair of Working Group III.

The United States is also involved in major international science programs which bear directly on the role of the oceans in shaping world climate: the Tropical Oceans-Global Atmosphere (TOGA) program; the World Ocean Circulation Experiment (WOCE); the Global Ocean Flux Study (GOFS); and the Global Ecosystems Dynamics Study. These projects are all part of a growing international effort to study the Earth as a system, and to better understand the processes by which human activities may alter the global environment.

Congressional Activity. Increasingly, global climate change has been on the Congressional agenda. Late in 1987, the Global Climate Protection Act was enacted (Title XI, Public Law 100-204). It assigned to the Environmental Protection Act (EPA) the task of developing and proposing to Congress a coordinated national policy on global climate change, and to the State Department, the task of coordinating U.S. policy requiring action through multilateral diplomacy. It requires EPA and the State Department to issue a report to Congress within two years which summarizes current international understanding of the greenhouse effect, the state of U.S. efforts at international cooperation, and the strategy by which further international cooperation is to be sought.

Recent meteorological events have spurred Congressional activity. Since January, 1988, there have been approximately two dozen Congressional hearings, and thus far, nearly a dozen bills have been introduced in the 101st Congress.

H.R. 980: THE GLOBAL ENVIRONMENT RESEARCH AND POLICY ACT

On February 9, 1989, Chairman Walter Jones and nine cosponsors introduced H.R. 980. This bill was referred to the Committee on Merchant Marine and Fisheries, the Committee on Science, Space and Technology, and the Committee on Interior and Insular Affairs. It contains three titles. Title I provides a statutory authorization and requirement for the Committee on Earth Sciences to develop and monitor implementation of a "National Global Change Research Plan". This plan is to provide for a 10-year program of national research on processes and factors which contribute to global environmental change. Title II establishes a Council on Global Environmental Policy within the Executive Office of the President, to be chaired by the Chairman of the Council on Environmental Quality. Title III amends Section 102(2)(C) of the National Environmental Policy Act (NEPA) to require that federal agencies consider the effect of their actions on the "global environment". A section-by-section analysis of H.R. 980 is attached to this memorandum (Attachment 2).

Atch #1

FIGURE 1

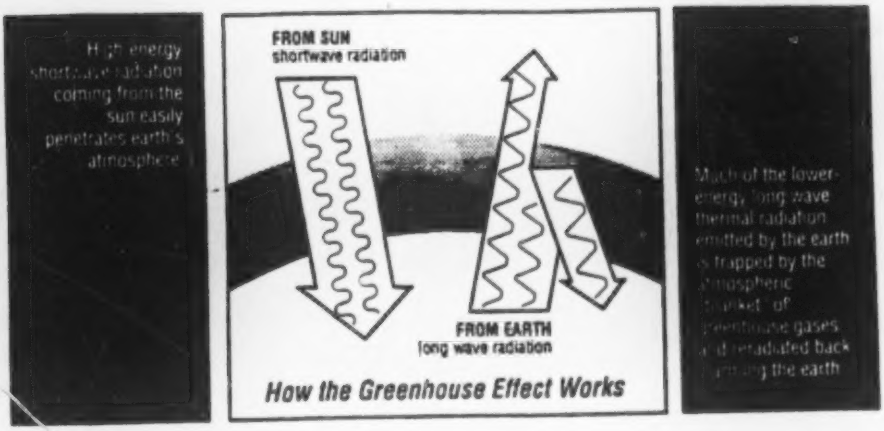
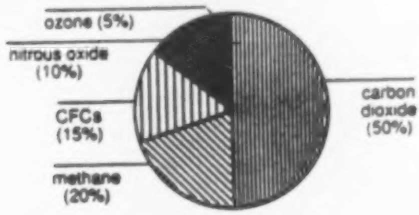

High energy shortwave radiation coming from the sun easily penetrates earth's atmosphere
FROM SUN
shortwave radiation
FROM EARTH
long wave radiation
How the Greenhouse Effect Works
Much of the lower-energy long wave thermal radiation emitted by the earth is trapped by the atmospheric "blanket" of greenhouse gases and reradiated back warming the earth

TABLE 1

Contributions of Various Gases to the Greenhouse Effect



Earth's total greenhouse effect is made up of the combined effects of several gases The chart shows the approximate proportion of the total warming contributed by each of the major greenhouse gases at the present time

A gas's contribution to the warming effect is not directly proportional to its concentration in the atmosphere. For example, chlorofluorocarbons (CFCs) are present in quantities of less than 1 part per billion, compared to 345 parts per million for CO —yet CFCs account for 15% of the total greenhouse effect because each CFC molecule causes the same amount of warming as 10 000 molecules of CO

Concentrations of all the major greenhouse gases are on the rise. Between 1975 and 1985, the percentage increases were

CO 4.6% CFCs 102%
Methane 11% Nitrous oxide 3.5%

Table 2
1989-1990 U. S. Global Change Research Program Budget
(Dollars in Millions)

Focused Program	Total Budget		Biogeochemical Dynamics		Ecological Systems and Dynamics		Climate and Hydrologic System		Human Interactions		Earth System History		Solid Earth Processes		Solar Influences	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Agency Totals	133.9	190.5	29.8	44.9	28.1	39.5	38.0	59.3	22.0	22.0	3.0	7.0	8.9	10.5	4.1	7.3
NSF	39.2	53.5	13.5	18.3	1.9	1.9	13.2	17.0	0.0	0.0	2.0	4.7	6.2	6.5	2.4	5.1
DOE	20.2	27.2	6.0	5.5	4.2	6.7	7.0	10.2	2.0	3.6	0.0	0.0	0.0	0.0	1.0	1.2
DOI/USGS	5.3	10.3	0.0	0.0	0.0	0.3	2.3	5.0	1.5	2.0	1.0	2.3	0.5	0.7	0.0	0.0
NASA	14.5	21.5	3.0	4.4	4.3	6.4	4.3	6.4	0.0	0.0	0.0	0.0	2.2	3.3	0.7	1.0
DOC/NOAA	9.0	20.0	0.0	3.0	0.0	0.0	9.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EPA	27.4	35.3	0.8	3.5	7.4	13.2	0.7	2.2	18.5	16.4	0.0	0.0	0.0	0.0	0.0	0.0
USDA	18.3	22.7	6.5	10.2	10.3	11.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Activity	133.9	190.5	29.8	44.9	28.1	39.5	38.0	59.3	22.0	22.0	3.0	7.0	8.9	10.5	4.1	7.3
Research	116.4	158.9	26.9	40.1	24.9	35.0	31.6	46.1	22.0	20.8	3.0	3.5	5.4	8.1	2.6	5.3
Observations	10.7	15.0	0.0	1.5	2.0	2.5	5.0	8.5	0.0	0.0	0.0	0.0	3.5	2.2	0.2	0.3
Data Management	2.3	8.1	0.4	0.8	0.2	1.0	1.4	4.7	0.0	1.2	0.0	0.0	0.0	0.2	0.3	0.2
Facilities	4.5	8.5	2.5	2.5	1.0	1.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	1.0	1.5

Atch #2

SECTION BY SECTION ANALYSIS:

H.R. 980, GLOBAL CHANGE BILL

SECTION ONE. SHORT TITLE.

The title of this Act is the "Global Environment Research and Policy Act of 1989.

SECTION TWO. FINDINGS AND PURPOSE.

This section contains findings regarding the known scientific, social and policy implications of global climate change. The section also outlines the purposes of the Act.

SEC. 101. DEVELOPMENT OF A NATIONAL GLOBAL CHANGE RESEARCH PLAN.

This section provides for the development of the "National Global Change Research Plan", a 10-year plan for a program of national research on the processes and factors which contribute to global environmental change. The Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) is required to develop and submit the Plan to Congress within one year of enactment.

Subsection (b) describes the contents of the Plan, which will identify the goals, priorities, and approaches for global change research conducted and funded by the Federal government and provide for the coordination of relevant programs and activities of federal agencies. The plan would also incorporate and coordinate appropriate research activities conducted under the National Sea Grant College Program and the global change research activities of other nations and organizations

The allocation of research responsibilities among participating federal agencies is set forth in subsection (c). The National Oceanic and Atmospheric Administration is allocated primary responsibility for the development of observation and predictive modeling capabilities of ocean and atmospheric processes, including ecosystem diagnostics and prediction. The National Science Foundation is allocated responsibility for basic research in the areas of Earth, atmospheric, and ocean sciences, including the biological sciences. The National Aeronautics and Space Administration is allocated primary responsibility for Earth science research missions from space and advanced remote sensing instrument development. The United States Geological Survey is allocated primary responsibility for geological studies and mapping.

The use of existing reports and studies in the development of the plan is mandated under subsection (d). Subsection (e) requires FCCSET to submit the Plan to Congress within one year after the date of enactment and to revise the Plan at least once every three years under subsection (f).

SEC. 102. IMPLEMENTATION OF THE PLAN.

This section provides for the implementation of the National Global Change Research Plan by the FCCSET. Subsection (b) requires the Chairman and the Secretary of State to cooperate in providing representation at international governmental meetings and conferences on global change in which the United States participates.

SEC. 103. BUDGET COORDINATION.

This section requires each federal agency involved in global change research to include in its annual request for appropriations, a report to the President and the Council. The report will identify each element of the agency's proposed global change activities stating how it contributes to the implementation of the Plan and the specific request for appropriations under each element. The President is required to identify in the annual budget submitted to Congress the portion of each agency's annual budget that is allocated to global change activities under subsection (b).

SEC. 104. REPORTS

This section requires the Chairman to report on the specific activities of the Council under the Act, including a summary of the achievements of federal global change research efforts, an analysis of the progress made toward achieving the objectives of the Plan and recommendations regarding additional action or legislation which may be required to assist in achieving the purposes of this Act. Upon the completion of research activities specified under the Plan in subsection (b), a final report shall be submitted to the President and the Congress within ten years of enactment.

SEC. 201. ESTABLISHMENT OF THE COUNCIL ON GLOBAL ENVIRONMENTAL POLICY.

This section establishes the Council on Global Environmental Policy (CGEP) in the Executive Office of the President.

SEC. 202. MEMBERSHIP OF THE COUNCIL.

This section describes the membership of the Council, which is composed of 11 members including the Director of the Office of Science and Technology Policy, the Chairman of the Council on Environmental Quality, and representatives of Federal agencies charged with national global change research missions. The Chairman of the Council on Environmental Quality will serve as CGEP Chairman.

SECTION 203. FUNCTIONS OF THE COUNCIL.

This section outlines the functions of the CGEP. In advising the President regarding domestic and international policies, plans, and programs related to global environmental change, the CGEP shall recommend approaches for coordination of policies and programs of all Federal and State agencies related to the impacts of global environmental change. The Chairman shall also make recommendations to the Federal Coordinating Council on the research goals and priorities which most effectively provide a basis for policy decisions related to global environmental change.

SECTION 204. REPORTS.

This section requires the CGEP to report annually to the Congress and the President regarding global environmental change activities during the preceding year and related regulatory and legislative matters. Subsection (b) requires the Council to submit a five-year policy report to Congress and the President consisting of a comprehensive program to abate, mitigate, and adapt to the impacts of global environmental change.

SECTION 301. IMPACT OF MAJOR FEDERAL ACTIONS ON THE GLOBAL ENVIRONMENT.

This section amends NEPA to require the federal agencies to consider the impact of their actions on the oceans, the atmosphere, and other aspects of the global environment.

SECTION 302. DEFINITIONS.

This section includes definitions relevant to the provisions of this Act.

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SAVING THE SEAS

OPTIONS FOR REDUCING ENVIRONMENTAL RISK

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I wish to thank the Chairman, Congressman Hertel, for the opportunity to testify before this subcommittee on the central issue of global climate change.

Two aspects of global change issues are striking to any observer. The first is the rapidity with which the problem is entering the public and political consciousness, as evidenced by the level of press coverage and Congressional activity and the second is the dramatic shortening of the projected time before the effects of climate change and sea level rise begin to be felt. Public awareness is obviously a function of the closeness of the consequences, but what is remarkable is the desire to address what all of us recognize as the most challenging environmental, economic and political issue we have ever faced.

The complexity of human-caused global environmental change arises because of the intrinsic linkages that exist among the major issues considered here, the so-called "greenhouse effect" in which the emission of carbon dioxide and other gases released by energy production, agriculture and industrial processes contribute to global warming. The greenhouse effect and the emission of gases are linked to a host of related critical problems including climate modification, sea level rise, deforestation, acid rain, air pollution and stratospheric ozone depletion.

It would be more than a little presumptuous to assume that one could even identify all of the issues that Congress should address in a paper of this scope, much less describe all of the policy options that should be considered. Despite these reservations, I hope to provide a focus for the discussion of a Congressional agenda that addresses near-term global change policy options.

Before examining specific proposals, it is important to state the context in which they are being offered. Despite the extensive work to date, many uncertainties remain about both the timing and the extent of global climate change.

A pattern of global warming that has a distribution over the earth and atmosphere with predictions of the greenhouse theory has been recently reported. Because the temperature increases are slight, however, most scientists would like to observe a pattern of consistent effects before claiming that the human-induced greenhouse effect has been detailed. Some scientists predict that a definitive greenhouse fingerprint will be detected within a decade, and at least one suggests the evidence is already here.

The dilemma of waiting for conclusive proof in the face of such severe potential consequences is illustrated by the international Policy Issues Workshop held at Bellagio, Italy in November 1987 which suggested that it might be thirty years before we would have definite proof that climate change was linked to our emission of greenhouse gases. The report, released on June 6, 1988, also concluded, however, that a decade after confirming the greenhouse connection, we could expect a global temperature rise of 2.2 degrees Fahrenheit, and an increase in sea level of three-quarters of a foot (middle range scenario).

Because of numerous uncertainties, however, the Bellagio group estimated that by 2030 there was a ten percent chance that warming could be less than 0.4 degrees F with a slight decline in sea level or that temperature rise could exceed 6.0 degrees F with a sea level rise of more than 3 feet. Even these dramatic figures, which imply global warming rates 10 to 100 times those that have ever occurred, and the warmest average global temperatures in the past 100,000 years, do not reveal the full extent of future warming commitment that will be realized a few decades later.

To gain some insight into why the near future holds such dramatic changes in store when so little evidence of greenhouse gas induced global change is evident now, one needs to examine the history of the release of these gases.

The greatest single contribution to global warming is carbon dioxide (CO2) which is released in the combustion of fossil fuels. While CO_2 has been released to the atmosphere since the beginning of the industrial revolution nearly 200 years ago, two-thirds of all of the excess carbon dioxide has been added in the past 35 years.

If the projections are accurate, 35 years happens to be the approximate amount of time we have in the future before major consequences of greenhouse warming become substantial. Carbon dioxide and other greenhouse gases are certain to accumulate further during this period. Even were we to stop our additions today, we are committed to at least another 2.0 degrees F of warming, and many decades must pass before carbon dioxide levels dropped sufficiently to reverse the temperature rise.

We are therefore confronted by both the rate of change of global warming and its ultimate extent. Presumably, it will be easier to adapt to more gradual climatic change rather than to rapid change. Slow rates of change permit the introduction of a new, climate-dependent infrastructure as a regular replacement for old retiring facilities, and the development of new crops that are better suited to altered moisture and temperature levels.

Indeed, the Bellagio group recommends that we set a goal of 0.1 degree C increase per decade as a management tool. This figure is based upon an estimate of the maximum rates of adaptation of natural ecosystems and of human societies to past responses to climate change. While slowing down emissions to reduce the rate of temperature increase makes great sense, this strategy appears to be risky and unworkable.

There remain great uncertainties in our knowledge about the process of global warming, and we have an even poorer understanding of what a reasonable rate of increase should be. Finally, it seems an overwhelming task to create a fine-tuned global temperature control mechanism capable of responding to unforeseen natural events and the needs of the world's economy.

In addition to considering the rate of temperature increase, it is also necessary to determine whether there exists some upper level of change that is likely to be within the bounds of reasonable adaptability. Warming by 5.5 degrees F, equivalent to that induced by a doubling of pre-industrial atmospheric CO_2 to around 540 parts per million (ppm), is often used as a benchmark for comparison, but probably exceeds a warming level to which we might readily adapt. Were carbon dioxide the only greenhouse gas, such an increase would not be expected before the end of the next century.

We now realize that other gases generated by human activity such as chlorofluorocarbons, methane, nitrous oxide and tropospheric ozone currently contribute as much to global warming as carbon dioxide. With an observed rise of nearly 1.0 degrees F during the past century, and a commitment from all these gases to an even greater temperature increase from emissions already in the atmosphere, it is now possible that warming equivalent to a doubling of CO_2 could be realized during the decade between 2030 and 2040. Without active intervention to reduce greenhouse gas emissions, temperature increases will, of course, continue their rise to catastrophic levels in the decades to follow.

The consequences of greenhouse warming are projected to be quite severe. The relatively modest rise in global average temperatures is magnified several fold as one moves toward the poles. This may cause significant changes in weather and precipitation patterns with a major drying and warming of the present American grain belt during the growing season. The creation of desert-like precipitation patterns for the mid-continent would come just as we approach the depletion of the aquifer which underlies it.

The implications for crops, forests, and other ecosystems are profound: the advantages of CO_2 stimulated plant growth offset by increased drought, forest fires and species loss, a decline in forest and tundra ecosystems and an expansion of grasslands and desert. Few forests, for example, could move rapidly enough in response to current rates of temperature change with devastating consequences for many of our National Forests, Parks and Wildlife Refuges. Existing irrigation and hydroelectric projects might no longer receive adequate rainfall, and many new projects may have to be built.

Finally, as indicated above, significant sea level rise appears to be inevitable with serious implications for coastal populations, cities, water supplies, harbors and estuaries. We can get some sense of the consequences of a sea level rise of a few feet by observing the havoc created by similar rises in the levels of the Great Lakes and the Great Salt Lake.

While sea level rise would create strong incentives for urban renewal in some of our coastal cities, the cost of either moving them or building protective barriers would probably be in the range of hundreds of billions of dollars. For example, a recent study estimated the cost for a modest sized city like Charleston, South Carolina, to adapt to expected sea-level rise as $1.5 billion.

The Dutch have just completed the Deltaworks Project near the mouth of the Rhine which protects a few miles of coastline at a cost of over $5.0 billion. Globally, more than one-third of the population lives along the coasts and a sizeable number would be adversely affected by rising sea level. EPA has apparently just begun a study of the economic costs of sea-level rise, but much more needs to be done to determine the cost of adaptive strategies and outright losses from global changes of this kind.

What factors might we keep in mind as we attempt to set priorities for Congressional responses? The seriousness of the projected consequences and their time frames and degree of irreversibility provide important yardsticks against which we can measure various policy proposals. Despite the irreversible, adverse consequences of our release of greenhouse gases, the focus of concern appears to be more on the irreversible impact of policy changes that might be enacted to solve these problems.

What if we are mistaken and there is no global warming? One way to approach this dilemma is to initially phase in those policies that are most easily reversed, that have the lowest negative impact on the current economy, are most effective in reducing greenhouse gas emissions and which have additional environmental and economic benefits as well. In any case, there exist many problems which we should be addressing that happen to be linked to the greenhouse issue. By a proper choice of action, we can effectively address both a problem like stratospheric ozone depletion and global warming.

Considering these factors, we suggest that the following options be considered:

- First, build up support for research and long-term monitoring so as to have a sound basis on which to base medium and long range policy.
- Second, insure that the federal government is properly organized to respond to this complex problem that cuts across so many departments and agencies.
- Third, develop and implement international policies and strategies to deal with this global problem.
- Fourth, begin to implement policies that will slow the growth of greenhouse gases in the short term.

- Fifth, prepare strategies for adapting to unavoidable climate change.

RESEARCH INITIATIVES

Our new awareness of the extent and timing of greenhouse effects has occurred as the result of new research tools and new strategies for carrying out "global science." Without the contribution from satellites, a worldwide network of monitoring stations, research laboratories, interdisciplinary institutes and the array of regular and supercomputers to correlate the data and model the complexities of climate, we would remain blissfully ignorant of the threat we face. The obvious challenge to scientists is to develop more accurate predictive models, and to devise a more sensitive test that can identify a greenhouse fingerprint or lack thereof as soon as possible.

To achieve those goals, there must be a sustained, decades-long scientific research effort which I suggest calling the "Global Change 2020 Program." Its goal would be to provide us with a clear vision of the greenhouse problem and its relationship to other serious issues before the year 2020 so that we can continue to employ cost-effective preventative policies and adaptive responses. The program would include our own domestic research such as that outlined by the Earth Systems Sciences Committee of the NASA Advisory Council, and similar programs at NSF and NOAA and the U.S. contribution to international projects through the International Geosphere Biosphere Programme (IGBP), research coordinated by the United Nations Environment Programme (UNEP) and various bilateral efforts such as those recently agreed to by the United States and the Soviet Union at the recent summit.

Congress will need to provide significant new funds to insure that satellites for remote monitoring and experiments are available as are the computers needed to handle the monitoring data and to model the results. In addition to the need for new satellites like the polar platform, Congress should determine whether funding should be provided for equipment like Landsat that is slated for abandonment. Considerable research needs to be supported to understand the continuing increases in methane and nitrous oxide, two important greenhouse gases. The development of strategies to reduce the important air pollutant and greenhouse gas, tropospheric (lower atmosphere) ozone should also be a high priority. Much more work needs to be done on climate dynamics, especially non-linear effects. We also need to increase our understanding of the role of the biosphere in climate change, and the implications for a range of representative ecosystems utilizing both space and ground level observation.

All aspects of global change research and monitoring are currently underfunded, even in the short term. Yet they could be expected to provide major insights into the greenhouse and other linked problems. Responsibility for particular programs must continue to evolve among NASA, NOAA, NSF, EPA, the Departments of Energy, Interior and Agriculture. Enhanced authority to coordinate and shape priorities and insure cooperation among agencies, universities, the private sector and international research efforts also needs to be provided to some office within the government.

A second area of needed research is the exploration of policy options. It may seem peculiar in a presentation of policy options to advocate research on the very proposals being advocated, but we need to learn which mechanisms are likely to be the most effective in reducing greenhouse gas emissions most rapidly, most completely, most economically and with least disruption to society. Because the necessary actions will be so pervasive, it is essential that they have a high degree of support by the public in order to be both politically acceptable and capable of being implemented.

The U.S. and other nations now have some experience with several strategies designed to reduce pollution and promote energy efficiency. There also exists a significant body of general research on the relative merits of tax breaks, gasoline or oil import consumption taxes, pollution (in this case carbon) taxes, incentives, trade-offs, penalties, regulations and negotiations. What is needed is to apply each of these ideas -- and any others one can think of such as the imaginative debt for tropical forest swap -- to specific greenhouse problems in order to determine which approach is most effective in which circumstances. Carrying out policy research is perhaps the only possible way to resolve the ideological biases that engulf most policy debate.

ORGANIZING GOVERNMENTAL RESPONSE

The difficult challenge to policy makers is how to respond to such a supreme threat when the only evidence is a theory, the prediction of computer models, data revealing a slight warming over the past century, some tantalizing paleoclimate evidence and a lot of uncertainty. If one is to give any credence to the predictions, then it is clear that some action is essential long before we can be certain of the extent of future damage and its timing. Waiting until we are certain that our own emissions are increasing global temperatures, could well commit us to ruinous levels of climate change.

Let me suggest that even though the greenhouse problem is more complex, it bears a superficial resemblance to national defense issues. In both cases we are confronted with possible, massive destructive consequences of uncertain extent at some unknown time in the future. Not wishing to risk the consequences of being inadequately prepared, our response to a possible military threat has been to develop defenses, never knowing for sure whether the weapons we build will stave off some future war. By contrast, we know for certain that we can prevent or postpone major induced climate changes by decreasing the release of greenhouse gases into the atmosphere.

While I would hope we could develop less lethal defenses against climate change than we have against perceived military threats, I must agree with Stephen Schneider of the National Center for Atmospheric Research who has argued very persuasively that it would be a serious mistake not to treat the greenhouse threat as an equally serious strategic defense problem. To respond effectively will require mobilizing government authority and resources in new arrangements. Rather than create a new "pentagon for global climate change," it is far more realistic to divide the many aspects of this problem among the appropriate departments and agencies and then to develop an effective means for coordinating them. In some ways we have already begun since a number of the scientific aspects are already coordinated by the National Climate Program.

For Congress there is the additional challenge of organizing the task of gathering the necessary information, developing and passing authorizing legislative and then appropriating the necessary funding to implement the many facets of a complex response to a complex problem.

A look at the various dimensions of the problem suggests that at least a dozen, different subcommittee jurisdictions and as many federal agencies, (not to mention state and local governments and the private sector) might be involved. Simply allocating tasks among the agencies and figuring out coordination mechanisms will be a major task. High level positions will need to be created at the EPA and the Department of Energy, and coordinating offices will be necessary in the Departments of State, Interior, Agriculture, Housing and Urban Development and Defense. To be certain that responsibilities are met in a coherent way requires that ultimate responsibility be vested in a single Cabinet-level official with sufficient staff to coordinate the research and policy implementation.

There is one action that could be implemented quickly, would cost very little, requires no irreversible actions and yet is effective in increasing awareness of the greenhouse problem. Congress should require that federal agencies consider the implication of their actions for global change issues such as the greenhouse effect, sea-level rise, stratospheric ozone depletion and tropical deforestation as part of environmental impact statements (EIS) filed under NEPA. Congress may also want to require comments on global change when issuing new regulations or when reviewing certain continuing agency activities that might not normally be considered eligible for the EIS process.

To summarize, there is a critical need to coordinate global change research and policy within the federal government. It is also essential that a long range plan and strong commitment to that program be established and maintained. In considering such a program for the U.S., we should keep in mind the need to participate actively in international efforts in both developed and developing countries since the consequences of this great unauthorized experiment will affect all of us.

Thank you Mr. Chairman.

STATEMENT OF
ROBERT W. SLOCUM, JR.
EXECUTIVE VICE PRESIDENT
NORTH CAROLINA FORESTRY ASSOCIATION
ON H.R. 980
"THE GLOBAL ENVIRONMENT RESEARCH AND POLICY ACT OF 1989"
HOUSE COMMITTEE ON MERCHANT MARINE AND FISHERIES
SUBCOMMITTEE ON OCEANOGRAPHY AND THE GREAT LAKES
MAY 4, 1989

Mr. Chairman, members of the Committee, my name is Robert W. Slocum, Jr. I am the Executive Vice President of the North Carolina Forestry Association (NCFA). Prior to this, I was Vice President, Forest Policy and Research with the American Forest Council in Washington, D.C. In 1984, we worked with the EPA and other organizations to put together one of the first conferences on global climate change and forest impacts.

We in North Carolina are concerned about the potential impacts of global climate change. We recognize that significant changes in our environment will impact our forest resources and the economic and environmental benefits we get from them. In North Carolina, we have 18.5 million acres of timberland--4th in the nation--which support a forest products industry that ranks second in the state in value of shipments ($10.6 billion), employment (145,000) and payroll ($2.5 billion). Additionally, our forests provide habitat for 80 of the game species hunted and for fresh water fish. Some 2.2 million people spent $1.2 billion in 1985 for hunting and fishing in the state. Potential impacts on the health and productivity of these resources are certainly important to our state.

H.R. 980

The establishment of a coordinated, focused, program to identify goals, priorities, and approaches for global climate change research is essential. A program should be designed to provide a sound, scientific basis for developing national and international policy on global changes issues. The concepts embodied in H.R. 980 appear to meet this need.

It is important to note that significant scientific uncertainty and speculation surround the issue of global climate change. For example, what is the relative contribution of specific greenhouse gases to potential future climate change? What is the rate of man-caused change? What are the potential impacts on forests and society? What are some potential solutions? These and certainly other questions need to be answered to ensure the future productivity of our forests and to avoid ill-conceived mitigation programs.

H.R. 980 directs the Federal Coordinating Council for Science, Engineering, and Technology to develop a coordinated research plan which will establish the goals and priorities for Federal global change research. The bill also identifies specific existing agency missions and responsibilities for research. Although many agencies are not specifically mentioned, I urge that attention be given to the concept of placing research responsibility directly with the agency best suited to carry out specific research needs. For example, the U.S. Forest Service along with the universities they directly interact with, are best suited to carry out research on forest effects and impacts and to examine terrestrial mitigation systems to slow the increase of greenhouse gases.

I also recommend that funding for specific research be allocated to support the best science available--not just to support an agency. Competitive grant programs have a proven record of stimulating new, innovative research to address specific needs.

Possible Policy Responses Relative to Forestry

Despite the uncertainty surrounding this issue, it is not prudent to simply await the results of this research. There are several actions concerning forest management and utilization that can both directly and indirectly help minimize concentrations of CO2 in the atmosphere.

- The planting of new forests and regeneration of forests following harvest will help consume CO2. The American Forest Council estimates that over 2.3 billion seedlings per year can be planted covering about 3 million acres of land. These new forest would consume up 9.2 million tons of CO2 per year.

  Additionally, the United States should work with and encourage other nations to regenerate their forests after harvest. Tropical forests can be managed for sustained production of fuelwood, forest products, and the many other benefits provided by well managed forests.

- Land managers should manage forests more productively and in a healthier condition in order to increase CO2 consumption and reduce their susceptibility to insects, disease, and fire. Genetic tree improvement programs, which can both increase growth rates and decrease susceptibility to insects and disease, should continue. It should be pointed out that overmature forests, particularly those where no management occurs, are a net source of CO2 because they decay as fast as they grow.

- Manufactured wood products that serve to store CO2 in the structural material should be substituted for other materials wherever possible. Proper treatment of wood can prolong the useful life of wood products by up to forty times.

- Renewable wood should be utilized in place of conventional fossil fuels that release CO2. The scientific community has established with relative certainty that 80% of CO2 emissions result from the burning of fossil fuels.

- Forests as well as individual trees serve to shade and thus cool the Earth's surface which can reduce air conditioning costs and energy use. Planting of shade tree could, according to some sources, potentially offset CO2 emissions by 18 million tons per year.

Mr. Chairman, I also urge you and your colleagues to consider how seemingly unrelated actions on taxation and regulation affect our ability to productively manage our forests. The recent elimination of the capital gains tax differential for timber appears to have adversely affected forest management by private landowners. Also, the continued proliferation of environmental regulations without consideration of costs and benefits is also causing problems.

The objectives of the Global Climate Change Research Program are sound. Attempts to respond to hypothetical climate changes without a strong scientific basis could be futile and very costly. We must monitor, understand and ultimately predict global change. Only then can we develop a sound and defensible policy on this issue.

Statement of the U.S. Chamber of Commerce

ON: THE GLOBAL ENVIRONMENT RESEARCH AND
POLICY ACT OF 1989 (H.R. 980)

TO: SUBCOMMITTEE ON OCEANOGRAPHY OF THE HOUSE
COMMITTEE ON MERCHANT MARINE AND FISHERIES

BY: SUSAN C. MOYA

DATE: MAY 4, 1989

The Chamber's mission is to advance human progress through an economic,
political and social system based on individual freedom,
incentive, initiative, opportunity and responsibility.

The U.S. Chamber of Commerce is the world's largest federation of business companies and associations and is the principal spokesman for the American business community. It represents nearly 180,000 businesses and organizations, such as local/state chambers of commerce and trade/professional associations.

More than 92 percent of the Chamber's members are small business firms with fewer than 100 employees, 59 percent with fewer than 10 employees. Yet, virtually all of the nation's largest companies are also active members. We are particularly cognizant of the problems of smaller businesses, as well as issues facing the business community at large.

Besides representing a cross section of the American business community in terms of number of employees, the Chamber represents a wide management spectrum by type of business and location. Each major classification of American business—manufacturing, retailing, services, construction, wholesaling, and finance—numbers more than 10,000 members. Yet no one group constitutes as much as 32 percent of the total membership. Further, the Chamber has substantial membership in all 50 states.

The Chamber's international reach is substantial as well. It believes that global interdependence provides an opportunity, not a threat. In addition to the 59 American Chambers of Commerce Abroad, an increasing number of members are engaged in the export and import of both goods and services and have ongoing investment activities. The Chamber favors strengthened international competitiveness and opposes artificial U.S. and foreign barriers to international business.

Positions on national issues are developed by a cross section of its members serving on committees, subcommittees and task forces. Currently, some 1,800 business people participate in this process.

STATEMENT
on
THE GLOBAL ENVIRONMENT RESEARCH AND POLICY ACT OF 1989 (H.R. 980)
before the
SUBCOMMITTEE ON OCEANOGRAPHY
of the
HOUSE COMMITTEE ON MERCHANT MARINE AND FISHERIES
by
Susan C. Moya
May 4, 1989

Mr. Chairman and members of the Subcommittee, I am Susan Moya, Manager of Energy and Natural Resources Policy, Resources Policy Department of the U.S. Chamber of Commerce. I am appearing today on behalf of the nearly 180,000 businesses, state and local chambers of commerce, and trade and professional associations represented by the Chamber.

The Chamber appreciates this opportunity to express its views on H.R. 980, "The Global Environment Research and Policy Act of 1989," introduced by Chairman Jones. The Chamber commends Chairman Jones for his legislation and supports in principle the bill's provisions to coordinate federal research and national global climate change policy efforts and to establish a multiyear research plan on global change caused by climate and other factors. These comments incorporate the Chamber's strategies for action on global climate change.

In response to the Subcommittee's request for the Chamber's views on the impacts of global climate change on the business community, appended is a copy of a Chamber paper discussing the possible economic and trade impacts of the current global climate change debate being presented today at the International Environment Bureau Symposium on Industrial Development and Climate Change.

Introduction

Global climate change is both a major scientific and political issue, and the two should not be confused. Although numerous articles on the subject have been written within the past year, including cover stories in both Time and Newsweek, conflicting information abounds.

There is no scientific doubt, however, that if certain trace gases in the atmosphere, notably carbon dioxide, methane, certain chlorofluorocarbons, and nitrous oxides (commonly called "greenhouse gases") accumulate to an as yet undetermined critical point, enough heat radiation from the earth will be trapped and the atmospheric temperature will increase beyond society's ability to assimilate easily the temperature increase. Note that there are two unknowns here: what that critical point is and how much society can assimilate.

The Chamber believes that any man-made climate change is cause for the most serious concern and action -- the right action -- because the wrong action could create more severe consequences.

Chamber Action Strategy and H.R. 980

Earlier this year, the Chamber distributed to Members of Congress its discussion paper Global Climate Change: Cause for Concern, NOT Panic, which suggests some parallel courses of action.

One course is to gain a better scientific understanding of global climate change in order to improve the capability to predict and respond to such changes, whether naturally occurring or the result of societal activities. H.R. 980 would start us on this course by directing, prioritizing, and beginning to institutionalize federal interagency global climate change research efforts.

Another course of action is to take those steps that make sense now, on their own merits, regardless of whether or not the global atmosphere is warming. Of course, the U.S. must play its fair part in such activities, but it is important to recognize that this is a global problem that requires international cooperation. No one country's actions, however ambitious, can significantly affect global climate change.

As H.R. 980 correctly recognizes, currently, as many as nine national and international organizations are involved in global change research activities. No fewer than 12 U.S. federal departments and agencies are attempting to understand the Earth as a global ecosystem. Clearly, these organizations need prioritized goals, plans, and a framework for their research activities. H.R. 980 provides such coordination, focus, and structure through the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), part of the Executive Office of the President, and chaired by the President's Science Advisor.

Reliable information, predictions, and assessments of the complex phenomena of the global system are important. For example, global warming could require changes in agricultural policies, modes of energy production and usage, development and protection of natural resources, and coastal-zone management. The Chamber fully agrees with the bill's finding:

> Development of effective policies to abate, mitigate, and adapt to human-induced and natural global changes will depend on our ability to understand global environmental processes, predict global environmental changes, and distinguish between the effects of human activities and the results of natural changes.

The Chamber commends the bill's sponsors for recognizing the value of a multiyear research plan to identify priorities for scientific research and monitoring efforts on global change. However, based on past experience with the National Acid Precipitation Assessment Program (NAPAP), whose developmental plan took several years to prepare, we must question whether H.R. 980's allotted one year is sufficient time for the FCCSET adequately to develop a plan for submission to Congress, especially considering that the plan will be subject to public review and comment.

The Chamber believes that scientists around the world must work together toward a better understanding of global climate change. H.R. 980 recognizes this need by requiring that there be a coordination of "the global change research activities of the United States with programs of other nations and international organizations, including the World Meteorological Organization and the United Nations Environmental Program."

All federal global climate change research activities should be identified in an integrated manner in the federal budget, as provided in H.R. 980. This is necessary to help to eliminate duplicative efforts, to identify data gaps, and to provide for improved understanding of the scope and direction of the program by interested parties. The Chamber believes that private-sector input in reviewing the U.S. research agenda and in providing guidance on the establishment of research priorities is essential and urges that H.R. 980 include language to require such input.

The Chamber wishes to note five other observations about H.R. 980.

First, the bill does not include funding for either the FCCSET or the Council on Global Environmental Policy. If they are to be effective, sufficient operating money should be a consideration.

Second, the bill is vague as to how the two councils are intended to interact with each other and with other agencies. Which council or agency has authority is not clear. For example, Section 102(a)(1), which directs the FCCSET to "oversee" the implementation of the National Global Change

Research Plan, is unclear as to its intention. Is the FCCSET to develop the Plan, implement the Plan, or do the bill's authors intend FCCSET to have authority over other agencies to implement the plan? Such questions arose with NAPAP, which was not provided with sufficient direction or authority over other agencies. The Chamber suggests that a strong FCCSET chairman is needed to coordinate activities, set budgets, and provide leadership and direction.

Third, the Chamber strongly supports H.R. 980's provisions that require FCCSET at least every three years to revise the Plan and submit it to Congress along with any recommendations regarding additional research. These provisions provide needed flexibility and allow for strategy and policy adjustments as more is learned about global climate change and new technologies are introduced.

Fourth, H.R. 980 provides that federal agencies and departments should continue established programs in which they have demonstrated expertise. This would avoid disruption of existing research efforts. The Chamber supports this continuity.

Fifth, the Chamber questions the need and value of amending the National Environmental Policy Act (NEPA) to broaden the Environmental Impact Statement (EIS) process to cover federal activities outside U.S. boundaries, specifically, to require federal agencies to consider international environmental impacts before undertaking major actions. According to recent testimony by Council on Environmental Quality (CEQ) Chairman Alan Hill before the Merchant Marine and Fisheries' Subcommittee on Fisheries and Wildlife Conservation and the Environment, the CEQ "is already addressing the questions of how federal agencies should consider the impact of their actions on global change, including stratospheric ozone depletion and global warming . . . Neither a statutory nor a regulatory change is needed to consider these issues in EISs." Additionally, the Chamber wishes to alert the Committee to the fact that agencies currently have the discretion to consider the environmental impacts of their actions on "the oceans, the atmosphere, and other aspects of the global environment," as stated in H.R. 980. Additionally, the scoping process under CEQ regulations for NEPA offers opportunity for the public to raise international concerns to be addressed in an EIS.

The Chamber repeats the admonition of others: much is still unknown about global climate science, making a NEPA assessment on the effects of federal actions on the oceans and atmosphere difficult, if not impossible. Thus, we question the wisdom of H.R. 980's NEPA requirement, which could decrease the effectiveness of an EIS by concentrating attention on speculative effects.

As research plans, such as those proposed in H.R. 980, are being formulated, the Chamber hopes that several questions will be given high-priority consideration. The answers to these will help to provide needed understanding in order to quantify the contribution of society's activities to global change and allow everybody, worldwide, to be prepared to act accordingly.

Some questions that must be addressed are:

o What effects do societies have on global climate change compared to the natural forces of weather and the small (but real) natural changes in the atmosphere and weather as the planet grows older?

- What are the principal uncertainties in the scientific bases for global climate change predictions and the consequences of those uncertainties?
- What are the anticipated future distribution and sources of "greenhouse gases"? How might this mix be changed without undue economic, environmental, and social costs? Do those affected understand these costs?
- What is the likely range of effects on energy development? Is the importance of energy development, which enables us to produce the basic necessities and amenities of life, duly recognized?
- What can the rest of the world learn from the U.S. in order to achieve economic growth and well-being with virtually no increase in carbon dioxide emissions?
- Which of the many proposed mitigation strategies will be effective? How do we avoid wasting effort, much less doing the wrong thing?

The role of science in this issue is to provide direction and scope for policy development. However, a number of things should be done now, on a parallel track with the above scientific research efforts. Policy that makes sense on its own merits can be adopted now. And, when more is known, we will better understand what other actions to take.

The Chamber urges the U.S. immediately to lead the way to:

- Educate people around the world about global climate change and the choices that may be necessary to avoid it.

- Support international cooperative research to advance the ability to predict the effects of such change and take needed moves to alleviate or avoid them.
- Implement actions to mitigate climate changes caused by man and assure that they make economic, social, and environmental sense on their own merits.
- Assist developing nations in joining global efforts while maintaining their economic growth by increasing research and development and trade incentives, by sharing land and forest management and new agricultural practices, and by other means.
- Remove unnecessary impediments to the adoption of alternative energy technologies and energy conservation.

Unilateral actions also should be taken. They include:

- Encouraging more energy conservation.
- Striving to gain acceptance of nuclear energy.
- Exploring alternatives to fossil fuels, such as wind power, photovoltaic cells, and solar collectors.

While embarking on the above, it is important that we not abandon established national energy and environmental policies in favor of those that may have profound unknown (and possibly negative) economic, social, and climatological effects. We must take care that our actions do not impose a wasteful and unfair burden on society.

Conclusion

Global climate change is neither a partisan nor a philosophical issue. The challenge for everybody, worldwide, is to act accordingly, at the right time. The Chamber believes that the parallel track of research and action provides an appropriate balance between information gathering and steps that we can take now.

The Chamber appreciates this opportunity to present its views on H.R. 980. It looks forward to working with the Committee on Merchant Marine and Fisheries on this important issue.

May 4, 1989
For Presentation: International Environment Bureau Symposium on Industrial Development and Climate Change, Washington, D.C.

POSSIBLE ECONOMIC AND TRADE IMPACTS OF THE CURRENT GLOBAL CLIMATE CHANGE DEBATE

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Introduction

The current concerns over global climate change arise from two key observations about the atmosphere: (1) there is a depletion of ozone in the stratosphere, especially over the north and south poles; and (2) there has been a rise in the concentration of carbon dioxide (and some other gases of interest) in the atmosphere since the beginning of the industrial revolution.[1]

Depletion of stratospheric ozone can result in an increase in the amount of short wavelength ultraviolet radiation reaching the surface of the earth. This would not cause a change in climate *per se* but would affect people's behavior in how they apportion their time and activities outdoors. Further, the increase in radiation may affect crops. There are scientific uncertainties here: the "hole" in the antarctic stratospheric ozone has been observed only recently; there is depletion over the arctic, although, a "hole" did not develop; and it is not known if "holes" existed before the introduction of ozone depleting compounds into the atmosphere, knowing that a "hole" is related to complex climatological factors.

Increases in the atmospheric concentration of carbon dioxide (CO_2) and other key gases (some associated with stratospheric ozone depletion) that are opaque to portions of the infrared spectrum result in the "greenhouse effect" or global warming. When short wavelength infrared radiation from the sun warms the earth's surface, and this heat is later radiated from the earth, some gases in the atmosphere are not transparent to the longer wavelength re-radiation, the heat does not escape, and the atmosphere becomes warmer, much as does the interior of a greenhouse.

The greenhouse effect, despite all of the controversy surrounding it, is well based in physics and one of the most well-established theories in atmospheric science. For example, Venus has a dense CO_2 atmosphere and temperatures at its surface of near 1000° C. Nonetheless, there is argument -- or certainly less than unified opinion -- whether the earth is warming. The origins of the 1988 north American drought have been attributed to the greenhouse effect in the popular press, but not in the scientific press, where the origin has been attributed to many other factors.[2] At a 1988 Senate hearing, evidence was presented of trends of increased global temperature and computation of the prediction of a definite greenhouse effect.[3] Months later, the National Oceanic and Atmospheric Administration (NOAA) reported that there was no climate warming in the U.S. judging from 96 years of data.[4] The predictive computations can be questioned given the results of new satellite measurements of the heat radiation of clouds.[5]

The scientific controversy was described at the 1988 Senate hearing by then Energy Undersecretary D. Fitzpatrick as: "These scientific uncertainties must be reduced before we commit the nation's economic future to drastic and potentially misplaced policy responses." At the same hearing, S. Schneider, of the National Center for Atmospheric Research, replied we should "not use platitudes about scientific uncertainty to evade the need to act now."

There is broad consensus that global warming can occur but may not if mitigating steps are taken. The controversy is how much change can be expected, when it will happen, and where its effects will be most evident. Schneider has given an excellent summary of the uncertainties and policy implications of the observations.[6] He approaches the uncertainty issue with the view:

> "Whether some amount of scientific uncertainty is 'enough' to justify action or delay it is not a scientific judgment testable by any standard scientific method. Rather, it is a personal value choice that depends upon whether one fears more investing present resources as a hedge against potential future change or, alternatively, fears rapid future change descending without some attempt to slow it down or work actively to make adaptation to that change easier. That value choice can only be made efficiently by a society in which those involved in the decision-making process are aware of the nature of the scientific evidence."

It is clear at this time that many governments around the world have made the value judgment to proceed as if there will be global climate changes from unnatural (man-made) causes. It is against this background that possible economic and trade effects are discussed. To do so, it is not necessary to enter the debate of the nature, magnitude and timing of global climate change. It is only necessary to consider currently proposed responses. This is done in a global context, not focusing on any one country. However, the situation in the U.S. is stressed because more data are readily available.

Some Economic Effects of Global Warming

The mathematical models of global climate change predict average likely global temperature change and, to an extent, new global temperature patterns. From this, specific effects on natural ecosystems, water supplies, agriculture, sea levels, are inferred. Models are not capable of reproducing regional temperatures or precipitation. Nonetheless, there is qualitative agreement among prognosticators that sea levels will rise (although the evidence available is that the natural rise in levels has not accelerated[7]), wetlands will flood, salt water will infuse fresh water supplies, and there will be changes in the distribution of tree and crop species and agricultural productivity. Some writers have succumbed to the temptation to "predict" the quantitative extent of these changes, but such predictions are not much more than speculation. The "predicted" time scale for these changes ranges from decades to centuries.

A significant rise in sea levels will flood now habitable land in some countries, such as in Bangladesh, an already crowded country. Developed countries may be able to protect their cities, at least for a some years, by building levees and dikes at a considerable cost to avoid major displacements of people and their economic bases.

These same actions will affect wetlands and it may not be possible protect both coastal and wetland areas. Flooding will intrude into water supplies, such as in coastal cities (*e.g.,* Miami and New Orleans). In the Netherlands, it is expected that if the sea level rises a meter or more, large areas of the country will have to be flooded with fresh water to prevent saltwater intrusion.[7]

Changes in temperature patterns will affect natural ecosystems by altering the distributions of species. and affecting forestry and silvaculture. Under various scenarios, commonly harvested species will move north and try to grow in different soil types. Ranges of particular species are likely to change because trees in the southern part of the present range may die off much more quickly than they can propagate further north. Managed forests can survive if new species and strains can be developed in advance of any climate change.

Similarly, crop lands will change. In present farm areas, there will be greater reliance on irrigation. The stress will depend on changes in precipitation patterns, which is now difficult (at best) to predict. Grain production will move north and productivity may fall because of differing soil types. Global warming could expand the northern range of livestock diseases and pests.

Global warming will affect snowfall patterns, hence melt, and affect water supplies. Most of California's water supplies are from snow melt and if snow is reduced to rain, or melts quickly during the winter, water supplies in the summer will be less than now.

Likely Actions to Cope with Global Warming

Society does not have the resources to hedge against all possible future outcomes of global warming and other climate changes. Therefore, Schneider suggests a "tie-in" strategy of pursuing those actions that provide widely agreed societal benefits even if the predicted change does not materialize.[6] He suggests increased energy efficiency, reductions in emissions from many fossil fuels (especially from coal), development of alternative technologies such as in the development and testing of new crop strains, and trading agreements with nations for food or other climatically dependent strategic commodities. The consensus for "tie-in" strategies appears to favor some combination of emission reductions to slow the eventual warming and adaptation to an amount of inevitable warming.[7]

Schneider also raises the question whether it is more appropriate to subsidize poverty, for example, through artificially lower prices of energy which discourage its efficient use, or is it better to diminish poverty by direct economic aid. He suggests that it may be necessary to charge user fees on industrial activities in proportion to the amount of pollution each generates, a strategy which will differentially impact less developed nations, coal miners, or the poor, which raises questions of equity.

The actions likely to be taken by governments are: (1) reduce the emission of CO_2 by reducing the use or the mix of fossil fuels; (2) reduce the emissions of potential pollutants; (3) improve energy efficiency; (4) ban or restrict the manufacture of certain chemicals; and (5) seek to affect natural emissions of key chemical compounds. Each of these is discussed below in terms of its potential effects on economy and trade.

Trade effects are considered in terms of comparative advantage assuming a level playing field in the trade arena, recognizing this does not always happen. It is also assumed that all trading countries will adhere to future international compacts on global warming. Needless to say, large importing and/or exporting countries can distort any of the trade effects of global climate change by choosing to ignore, or seeking exceptions from, international agreements.

Reducing the Use of Fossil Fuels

Emissions of CO_2 (per unit of power produced) can be reduced by using a more thermally efficient fossil fuel-boiler combination, hence changing the mix among currently used fuels. The usual suggestion is to replace coal with natural gas. If this were done on a large scale, it would require the exploration, development and production of new gas fields. There would be a consequent reduction in production and export of coal. Both actions would affect the internal economies of coal and gas producing nations and affect the balance of trade among current coal trading partners. The cost of conversion of a coal-fired boiler to gas is relatively low. However, investments will be required for adequate gas delivery and distribution systems.

Displacement of coal by some other fuel will cause worker displacements in coal producing countries. Historically, coal miners have not found other employment easily. Hence, displacement of coal will likely cause large economic and social displacements which, in turn, will cause coal producing countries to seek some sort of aid for the workers. This economic disruption will be asymmetric, likely causing those affected to take action to defend their national economies. The wins and losses in the world economy are likely to be large.

Changes in fuel mix will not be well received by developing countries with large indigenous coal reserves who may not have domestic gas reserves or the capital to explore for and develop such supplies. These countries will be among the big losers and this alone could cause delays in reducing the amount of coal burned. At the same time, there must be analysis and consideration of what effect coal displacement will have on total worldwide CO_2 reduction. It is possible that the amount of CO_2 reduction from coal displacement will not be worth the economic result.

Fossil-fueled plants can be replaced with nuclear plants. If so, some risks will remain and the costs of development and gaining acceptance will be high. This option, too, will favor the wealthier nations or those who have already made a large investment in nuclear power, such as France, Japan, and to an extent the U.S., the U.K., and others.

The *per capita* generation of CO_2 in developed countries is, of course, much higher than in developing countries. One compilation ranks, in descending order, East Germany, U.S., Czechoslovakia, Canada, Australia, U.S.S.R. etc. down to India and Mexico.[7] However, if China meets its goal of raising its *per capita* gross national product to only 15% of the U.S. figure, the increase in CO_2 emissions in China would about equal emissions from all the coal consumed in the U.S. Similarly, if India maintains its current *per capita* emissions, its population growth will cause a similar increase in CO_2 emissions by the middle of the next century.[7] Clearly, even if very drastic steps to reduce CO_2 emissions in the U.S. were undertaken, it would not reduce worldwide emissions. This begs the question of developed countries giving some developing countries a "gift" of nuclear plants.

Alternative ways of reducing emissions are to use less energy, use it more efficiently, and to generate it from other than combustion. Non-use is not an option for a world economy based on energy intensity. Developing nations want to increase their energy use so as to improve the value added aspects of their economies and provide the basic necessities and amenities for their people.

Alternatives to fossil fuels (wind power, photovoltaic, solar collectors, etc.) are not being used because they currently cost more than fossil fuels. Hydroelectric power is in widespread use but there are not many more places for new major installations (and there are serious environmental and cost concerns). Aside from major new hydroelectric capacity, alternative generating technologies may benefit developing nations. These technologies are generally applied at small scales so that capital requirements are low. However, net cost per energy unit produced is likely to be uncompetitively high which would affect their international trade.

A major use of oil is for liquid transportation fuel and there are few viable alternatives on the horizon. If this use were cut back, say by fiat, reducing transportation would slow the economy of developed nations and hinder economic growth among developing nations. Not to be overlooked, large reductions in use of oil would seriously affect the economies of oil producing nations, many of which rely significantly on the revenues from oil exports to pay for their imports. Developed countries will have to increase their efficiency of transportation fuel use. In general, this means a switch to smaller and more efficient automobiles which has the related effect on economies of reduced manufacturing. Whereas workers may not be displaced, certainly the value added from the manufacturing is lowered.

Reduce Emissions

If there is to be international agreement to further reduce greenhouse gas emissions, this will give a competitive advantage to nations that have already invested in pollution control technology and will require considerable capital investment by countries that can ill afford it. If the effects of such investment around the world parallel those in the U.S., there will be increases in inflation and a lowering of GNP.[8] It has also been observed that increased spending on pollution control favors large plants over small[9] and results in a decrease in productivity.[10]

The principal contributor to the predicted global climate change is CO_2. A major source of this gas is from the combustion of fossil fuels. There does not seem to be any reasonable technological nor economic way to remove CO_2 emissions from combustion products so this form of emission control is not an option.

Another principal contributor to the predicted global climate change is methane. Some industrial releases are easy to control; other releases, such as from natural biodegradation (including from landfills) are more difficult. At the same time, there has to be an inventory of sources in order to learn if they warrant control.

Improve Energy Efficiency

One of the principal ways to slow down the rate at which CO_2 is generated is to invest in more efficient use and production of energy, including replacement of older power generating units. Such actions will favor the wealthier nations who can afford the investment. Devices and technology for improving efficiency are bases for new businesses. However, the inventions and developments will likely be in the wealthier nations. There should be considerable trade in means to improve efficiency and the trade victory will no doubt fall to those swift in acquiring the devices and means. It can be generally accepted that increased energy efficiency improves competitiveness.

Ban or Restrict Production

If the world community decides to ban the production of any chemical contributing to global climate change, such as certain chloroflurocarbons (CFC's), the ban must be equitable in two ways. First, any ban must be complete, with no long extensions that may favor one country over another. Second, bans should be implemented only if suitable substitutes are available. Bans should not remove the means (CFC's) of providing economical and safe refrigeration and air conditioning from nations' economies.

Restrictions are even more difficult. There already has been a restriction on the use of CFC's for aerosol products in the United States. This resulted in U.S. industry surrendering some of the market to other countries. If future restrictions of CFC's do not take this into account (and it appears the Montreal Protocol hasn't), then U. S. industry will make another sacrifice.

The ultimate restriction would be to place a cap on global productive capacity and to allocate portions among nations. The folly of such a plan should be self-evident given the inability of even individual nations to centrally plan their economies. There have been suggestions to allocate production within a country by imposing production charges (taxes) on certain fuels or products, with the related effect of having the magnitude of these charges distribute use of the products.[6] Such schemes may be appealing in theory, especially to those who advocate "market solutions" to all problems. However, these schemes presume a value can be assigned to the allocations. Even if a bid process were used to assign the values, the scheme clearly favors the most wealthy and would result in predation among nations and companies.

Affecting Natural Emissions

There are large natural sources of CO_2 and methane emissions, such as from the decomposition of organic matter, from volcanoes (which is the largest source of carbon monoxide), from ruminating animals (methane and carbon monoxide) and from mammalian exhale. Thus, CO_2 can be limited by control of the populations of animals and people.

There are serious concerns about methane in the atmosphere. There has been a linear increase in atmospheric methane in the past decade, current levels are more than twice as high as before the industrial revolution, and methane is one of the fastest growing greenhouse gases.[7] More than half of the methane released to the atmosphere comes from decay of organic material (including peat bogs, rice paddies and wetlands) and from ruminating animals. It is also released from coal mines, leaks from gas production and transportation, and landfills.

There are obvious economic consequences from the control of the population of people, both good and bad, depending on which country is being discussed. There are also obvious economic consequences of controlling the population of domestic animals. Certainly the world could move toward consumption of more vegetable protein, instead of animal protein, reversing the trend of centuries. If people would accept such change, there might be economic and trade benefits to grain producing nations and disbenefits to animal producing nations. However, even the grain producing nations with the largest comparative advantage would suffer because large quantities of grain are used for animal feed. Any major decrease in animal population would hurt farmers and ranchers. Historically, countries are prone to protect their farmers from international trade disadvantages so shifts in farm production is likely to result in protectionism.

The largest way to affect natural emissions may be to alter the CO_2 cycle by photosynthesis. Green plants absorb CO_2, metabolize it for growth, and emit oxygen. Indeed, reduction of tropical forests is often blamed for the increase in atmospheric CO_2. However, this blame is usually without cogent scientific analysis. Some questions remain concerning how much new forest (really green plant) growth is needed to make a difference and where should this growth take place. For example, can deforestation in Africa or South America be compensated by new plantings in North America?

Aestheticians will prefer planting of trees over other types of green plants. However, young plants are more effective in consuming CO_2 than mature trees. Short rotation forestry will have to be instituted in developing countries to provide both reforestation and firewood. However, these countries are likely to need aid in establishing and managing such crops. A balance must be found among the competing interests of growing plants and wood, the CO_2 that will result from the inefficient burning of the firewood, and providing fuel for people. The developing countries will have to find the economic means of establishing short rotation tree crops and equitable distribution of the fuel. Present wood-cutting and scavenging practices would have to be replaced with an economic allocation among the poor which probably means a subsidy scheme. It has been reported that only a small proportion of the fuel wood used by the rural poor comes from forests. Villagers rarely chop down trees but collect dead branches or cut them from trees. At the same time, 70% of the people in developing countries use wood for fuel.[11]

If deforestation is a large cause of climate change, and must be stopped, then those doing the deforestation must be offered an alternative. Forest products also provide foreign exchange. Poverty that requires cutting of fuel wood must be reversed by sustainable economic development and economic alternative silvaculture practices must be instituted by producing nations. To do otherwise has the large negative effect of maintaining poverty and reducing trade in needed hardwoods.

Predation Through Environmental Controls

An interesting analysis of environmental regulation in the U. S. concluded that certain industry groups and labor unions benefit from this regulation because of increases in profits and wages.[12] The thesis can be extended, at least qualitatively, to the effects on economics and trade that may result from worldwide imposition of new environmental controls.

Pronounced heterogeneity among firms and countries gives rise to competitive advantages due to asymmetric distributions of control and compliance. For example, if the regulatory cost burden falls heavily on one group of firms or countries, and lightly on another, then the indirect effect of the regulations is a cost advantage to the second group. Competitor damage and predator benefits accrue.

To the extent that there are economies of scale in compliance, smaller and/or less efficient enterprises or countries that have not yet invested in environmental regulation suffer a large unit-cost effect and exit the industry. Environmental regulations may affect one portion of the world more than others, similarly producing asymmetries that result in cost advantages.

In the United States, industries faced with stiff import competition are heavily damaged by regulation[9] and it is easy to see how any uneven installation or application of environmental restrictions will shift predatory benefits among nations.

A Policy Course

There is a spectrum of suggested policy actions. At one end, some favor immediate preventive actions, pointing to the uncertainties in prediction and effects. They argue that the effects could be far more severe or rapid than models predict. At the other end, others argue that reducing or curtailing emissions is so difficult and involves so many activities that are basic to human life, that global warming will be nearly impossible to prevent or even slow. They advocate adaptation, which obviously will be very expensive. Somewhere in the spectrum is a school of thought that there are so many uncertainties of timing and effects that society should not invest time or money until the problem is better understood. The more middle ground of some combination of emission reductions and adaptation is winning favor because, in part, of the greenhouse gases already in the environment. Economic and trade effects should be measured today against this middle view.

Controlling emissions of "greenhouse gases" (notably, but not only, CO_2) presents choices similar to many energy and environmental problems. There is a mix of social, strategic, economic and environmental issues that must be balanced. In all cases, not to do so will distort national economies and trade, as shown by the discussion above. As a basic premise, it would be unwise to establish energy and environmental policies that are driven solely by concerns over climate change.

There must be a better scientific understanding of the relationship between the magnitude and potential for these changes and the processes affecting the global carbon cycle. Valid and effective policies, based on their merit and not on speculation, can be established. At the same time, it would be a mistake to ignore the forecasts or to abandon established policies in favor of those that may have profound and unknown (and possibly negative) economic, social and climatological effects.

Noteworthy, the U.S. has sustained a long period of economic growth with diminishing emissions of CO_2. Fig. 1 in the Appendix shows graphs for the changes in CO_2 emissions and in GNP over the period from 1973 to 1988. Emissions peaked in about 1979, dipped and then rose again in 1988. However, at the same time, GNP increased steadily. More informative, Fig. 2 in the Appendix graphs the ratio of emissions to GNP over the period from 1973 to 1988. Over the entire period, the ratio decreases, showing increased economic output with decreased emissions. This experience is a lesson for the rest of the world, showing that sustainable economic development need not be accompanied by greatly increased emissions. The challenge is to identify what was done correctly and implement the policies elsewhere.

Sustainable economic growth is an imperative, especially among developing nations.[13] Only wealthy nations can afford strict environmental controls. U. S. experience is that the rate of CO_2 emissions *per unit of economic output* has declined. The developed nations have an obligation to continue this kind of growth and to teach the developing nations how to achieve similar results.

International cooperation is essential to mitigate potential man-made climate change. This cooperation must include the following steps.

- Educate people around the world about global climate change and the choices that may be necessary to avoid it.

- Support international cooperative research to advance everyone's ability to predict and act.

- Developed nations must take a pro-active role in implementing changes that will mitigate unnaturally caused climate changes. These actions must make economic, social and environmental sense on their own merits.

- Developed nations must assist developing nations in joining the global efforts while maintaining their economic growth. Some ways this may be accomplished are R&D growth, trade incentives, land and forest management, and adoption of new agricultural practices.

- Implement new global regulatory policies in an even-handed way so as to avoid predation.

The World Commission on Environment and Development suggested a similar policy course[14]: improved monitoring and assessment of the evolving global climate change phenomena; increased research to improve knowledge about the origins, mechanisms and effects; the development of internationally agreed policies for the reduction of the causative gases; and adoption of strategies needed to minimize damage and cope. The Commission concluded: "It is clear that a low energy path is the best way towards a sustainable future. But given efficient and productive uses of primary energy, including sustainable forms of renewable energy, this need not mean a shortage of essential energy services."[15] Although the Commission did not address economic and trade changes, it did add, "This requires profound structural changes in socioeconomic and institutional arrangements and is an important challenge to global society."

Discussion

The various proposed worldwide strategies to respond to potential global climate change have mostly negative effects on trade and the economies of developed and developing nations. At the same time, the proposed policy course must include a balance among the mix of social, strategic, economic and environmental issues.

There are going to be extremes of view. One will be that all decision making ultimately is reduced to a question of economics; another is that economic considerations must never play a part in issues affecting public health and the environment. There must be a middle ground of analysis and prudence or people all over the world will suffer.

Strict prevention policies will always be controversial because they involve, in some cases, substantial immediate investments against the possibility of future environmental changes. These can not be predicted with precision or assurance, leaving a question whether it is better to act now against a potential threat or wait until the threat is real. The economic answer to this question depends on the discount rate used to value potential future losses. For example, it has been estimated that damage from a sea level rise of 8 m could cost about $1 trillion (1971 dollars) some 150 years in the future. At a discount rate of 7% per year, this hypothesized loss is worth only some $33 million today.[16] The 8 m rise may not be probable[6], but the example is instructive. Of course, such an approach of discounting the far distant future may not be rational.

Two important caveats: First, no one country can be singled out for making proportionally more changes in their economy than others in order to mitigate global climate change. It is popular to ask the U.S. to make the greatest sacrifices, even though it has been calculated that the U.S. contributes some 5% of CO_2 emissions and this fraction could drop significantly if the U.S. reduces growth while other nations with large populations try to increase their GNP.[17] Another computation is that fossil-fuel plants in the U.S. are responsible for about 28% of the country's domestically generated CO_2 emissions, and that these emissions from all U.S. sources account for about 26% of worldwide CO_2 emissions. This means that U.S. power plants contribute just over 7% to worldwide CO_2 emissions, and half that when other greenhouse gases are taken into account.[18] Thus, the focus has to be on the economies of developing nations and a solution might be to construct nuclear power plants in these countries.

The second caveat is that before there are new global agreements to make large changes in national economies and world trade, there have to be sufficient analyses to provide a basis for choosing strategies. If, for example, photosynthesis can absorb enough excess CO_2 to avoid perturbating the economy, then there should be efforts to grow more green plants, wherever in the world they will have the greatest effect.

In this environmental issue, perhaps more than in any other, Pogo described it best: "We have met the enemy, and it is us."

APPENDIX

Computation of U.S. Emissions and Comparison to GNP

Emissions of CO_2 in the U.S. were computed from the energy use reported by the Energy Information Agency, U.S. Department of Energy, 1973-1988, for coal, oil and natural gas. These are listed in Table 1 in quadrillion (10^{15}) BTU (British Thermal Units). (Figures are taken from the October 1988 Monthly Energy Review (released January 1989). Figures for 1988 are estimated based on 10 month totals. Energy use was converted to CO_2 emissions in the following way.

A "typical coal" of 12,550 BTU/lb calorific value with a 70.4% carbon content was assumed. This is a reasonable choice based on listings of typical coals, such as in the *Handbook of Chemistry and Physics*.

A "typical oil" of 19,250 BTU/lb calorific value with a 84.8% carbon content was assumed. This, too, is a reasonable choice based on similar listings of typical U.S. crude oils.

A "typical gas" need not be assumed. Values used for methane were 1000 BTU/ft^3 with a density of 0.0423 lb/ft^3.

The computation of the amount of CO_2 produced is then:

$$[CO_2] = (\text{energy consumption/calorific value}) \times \text{carbon content} \times (44/12)$$

The factor (44/12) is the ratio of molecular weights of CO_2 to carbon. (The computation for natural gas includes multiplying by the density to convert ft^3 to pounds.) The results are listed in Table 1 in units of billions of tons. Note that many other such listings are in units of tons of carbon emitted, not CO_2. The CO_2 result can be divided by (44/12) to convert to tons of carbon.

Values for the U.S. Gross National Product (GNP) are from the *Statistical Abstract of the United States, 1988*. The value for 1988 was supplied by the U.S. Department of Commerce. Values for GNP are in constant 1982 dollars. These, too, are listed in Table 1.

Table 1 also lists the ratio of total CO_2 emissions to GNP, multiplied by 1000 so as to avoid listing very small fractions. (More significant figures are indicated for the listing of emissions than just justified by the data.)

Figure 1 graphs both the changes in CO_2 emissions (the bars) and changes in GNP (symbols and lines) over the time period from 1973 to 1988. Emissions grew until 1979, dipped through 1983, then leveled off until 1987 when they grew again, but to lower values than 1979. For almost every year during this time period, GNP increased year to year.

Perhaps more instructive is Figure 2, showing the change in the ratio of emissions/GNP over the same time period. There has been a steady decrease in this ratio since 1976, showing a decrease in emissions with an increase in economic output. The ratio for 1988 is slightly higher than for 1987; it is not known if this one point signals a trend.

It is significant that U.S. population in 1970 was 203,302,000 which grew to 226,546,000 in 1980. It was estimated to be 241,078,000 in 1986 (*Statistical Abstract of the United States, 1988*). There has to be a relationship between population and CO_2 emissions, but this was not explored.

Notes and References

(1) Some of the early measurements of the CO_2 content of air can be questioned because of subsequent improvements in analytical methodology. Early colorimetric titration techniques are known to be faulty. However, accounting for these errors may only shift the trends in concentration, not make them invalid.

(2) K. E. Trenberth, G. W. Branstator, P. A. Arkin. 1988. Origins of the 1988 North American Drought. *Science*. 242: 1640.

(3) J. Hansen. 1988. Testimony to Senate Energy Committee, 23 June. Hansen stated that the greenhouse effect was "99% likely to be associated with the recent temperature trends."

(4) P. J. Hilts. 1989. No Global Warming Seen in 96 Years of U. S. Data. *Washington Post*. January 27.

(5) V. Ramanthan, *et al*. 1989. Cloud-Radiative Forcing and Climate: Results from the Earth Radiation Budget Experiment. *Science*. 242: 57.

(6) S. H. Schneider. 1989. The Greenhouse Effect: Science and Policy. *Science*. 243: 771.

(7) B. Hilleman. 1989. *Chemical & Engineering News*. March 13.

(8) P. R. Portney. 1981. The Macroeconomic Impacts of Federal Environmental Regulation. *Environmental Regulation and the U.S. Economy.* H. M. Peskin, P. R. Portney, A. V. Kneese, editors. Resources for the Future. Johns Hopkins University Press. Baltimore.

(9)B. P. Pashigian. 1984. The Effect of Environmental Regulation on Optimal Plant Size and Factor Shares. *J. Law & Economics.* 27: 1.

(10) W. Gray. 1987. The Cost of Regulation: OSHA, EPA and the Productivity Slowdown. *Amer. Economic Rev.* 77: 998.

(11) World Commission on Environment and Development. 1987. *Our Common Future.* Oxford University Press. New York. pages 189, 190.

(12) A. P. Bartel and L. G. Thomas. 1987. Predation through Regulations: The Wage and Profit Effects on the Occupational Safety and Health Administration and the Environmental Protection Agency. *J. Law & Economics.* 30: 239.

(13) This has been called the "growth imperative" by the United Nations Environment Programme (UNEP). See: United Nations Environment Programme. 1981. *The Environment in 1982. Retrospect and Prospect.* Paper UNEP/GC(SSC)/2. Nairobi.

(14) Reference 11, page 176.

(15) Reference 11. Page 201.

(16) S. H. Schneider and R. S. Chen. 1980. Carbon Dioxide Warming and Coastline Flooding: Physical Factors and Climatic Impact. *Annual Review Energy.* 5: 107-40.

(17) S. H. Schneider, reference 6, footnote 73.

(18) H. H. Landsberg. Coal Revisited. 1989. *Resources.* No. 94. p. 10. Resources for the Future. Washington.

Table 1: Computation of Carbon Dioxide Emissions, 1973–1988

year	Heat Output coal	Emissions coal	Heat Output nat. gas	Emissions nat. gas	Heat Output oil	Emissions oil	Total Emissions	GNP 1982 $ trillion	Ratio (Tl.Emissions/ GNP) x 1000
1973	13.0	1.337	22.5	1.309	34.8	2.811	5.456	2.74	1.988
1974	12.7	1.306	21.7	1.262	33.5	2.706	5.274	2.73	1.932
1975	12.7	1.306	20.0	1.163	32.7	2.641	5.110	2.70	1.896
1976	13.6	1.399	20.4	1.187	35.2	2.843	5.428	2.83	1.920
1977	13.9	1.430	19.9	1.157	37.1	2.996	5.583	2.96	1.887
1978	13.8	1.419	20.0	1.163	38.0	3.069	5.651	3.12	1.814
1979	15.0	1.543	20.7	1.204	37.1	2.996	5.743	3.19	1.799
1980	15.4	1.584	20.4	1.187	34.2	2.762	5.532	3.19	1.736
1981	15.9	1.635	19.9	1.157	31.9	2.576	5.369	3.25	1.652
1982	15.3	1.573	18.5	1.076	30.2	2.439	5.088	3.17	1.607
1983	15.9	1.635	17.4	1.012	30.1	2.431	5.078	3.28	1.549
1984	17.1	1.759	18.5	1.076	31.1	2.512	5.346	3.50	1.527
1985	17.5	1.800	17.8	1.035	30.9	2.496	5.331	3.62	1.473
1986	17.3	1.779	16.7	0.971	32.2	2.601	5.351	3.72	1.438
1987	18.0	1.851	17.2	1.000	32.6	2.633	5.484	3.85	1.426
1988	19.0	1.954	18.3	1.064	33.6	2.714	5.732	4.00	1.435

Notes: Heat output units are in quadrillion BTU.
Emissions units are billions of tons of carbon dioxide.
GNP units are constant 1982 dollars (trillion).

Fig. 1: Total Carbon Dioxide Emissions and GNP Variations 1973 - 1988
Bars = Carbon Dioxide Emissions; Line = GNP

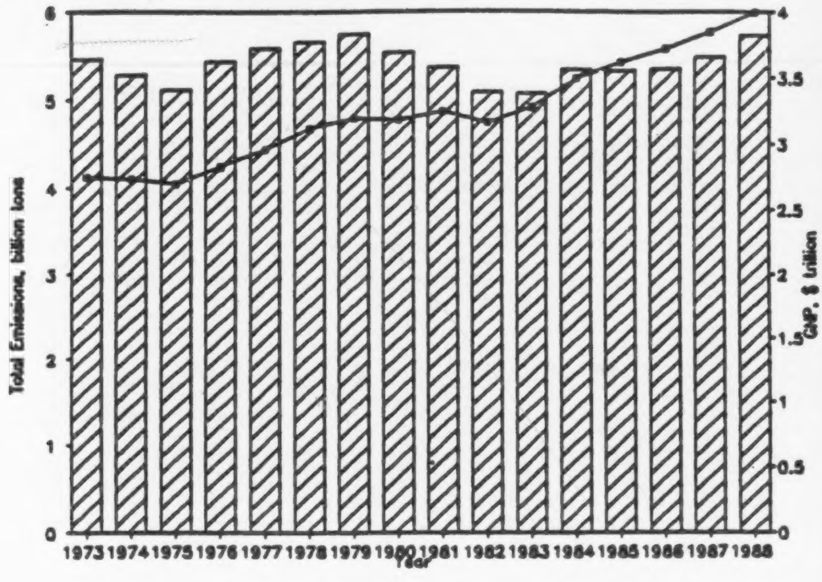
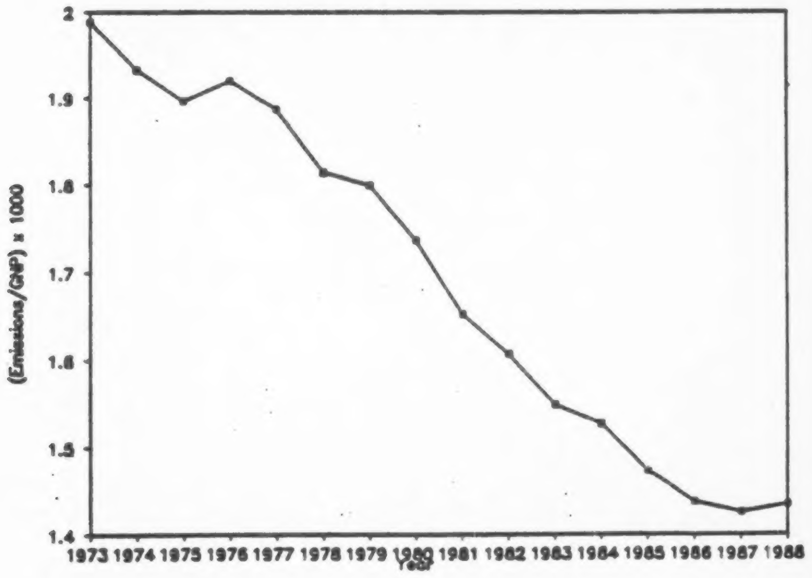


Fig. 2: Ratio (Carbon Dioxide Emissions/GNP) x 1000 from 1973 to 1988



U.S. Chamber of Commerce

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GLOBAL WARMING: IS IT REAL AND SHOULD IT BE PART OF A GLOBAL CHANGE PROGRAM?

Testimony of

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before

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United States House of Representatives

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GLOBAL WARMING:
IS IT REAL AND SHOULD IT BE PART OF A GLOBAL CHANGE PROGRAM?

I. The Scientific and Media Debate Surrounding the Greenhouse Effect.

The summer of 1988 saw a combination of events that quite literally catapulted the "Greenhouse Effect" out of ivy-covered halls of academe and the glass and stone of government offices into the public consciousness. Major drought, intense heat waves, forest fires, a super hurricane, and flooding in Bangladesh -- all the kinds of events that had long been forecast as associated with global warming from increasing greenhouse gas buildup -- occurred in that year. For months, magazine covers, news broadcasts, and newspapers were blanketed with stories of the extreme weather. These were often juxtaposed with stories on the greenhouse effect. It would be hard for an unscientifically trained listener or reader to have concluded anything other than that there was an intimate connection between the bad weather of 1988 and the buildup of greenhouse gases that had been increasingly discussed by a number of scientists (myself included)[1] for more than 15 years. Was this finally the proof that these academic warnings had indeed come true? On June 23, 1988, Dr. James Hansen of NASA's Goddard Institute for Space Studies (GISS) stated in front of the Senate Energy Committee that he felt that there was a "99%" chance that the unusually warm globally averaged temperature records he and a colleague had constructed for the 1980s could not have occurred by chance but rather were the result of the buildup of greenhouse gases.[2] He went on to point out that increasing the global temperature would increase the likelihood of extreme heat waves such as those that were occurring in 1988. He never said that the particular individual drought of 1988 could have been caused by the greenhouse effect, only that such events would increase in likelihood as the planet heated up -- not a very controversial view, and one that had been voiced by a number of others (myself included)[3] over the past 10 years. Unfortunately, the widespread publicity following the drought in general and that hearing in particular erroneously led to the impression that Hansen and many other climatologists believed that the greenhouse effect was responsible for the drought conditions in 1988. Neither Jim Hansen nor any other qualified atmospheric scientist I am aware of has ever made such a statement. For example, in a recent letter to the New York Times Hansen commented that "as I testified to the Senate during the 1988 heat wave, the greenhouse effect cannot be blamed for a specific drought, but it alters the probabilities. Our climate model, tested by simulations of climate on other planets and past climates on Earth, indicates that the greenhouse effect is now becoming large enough to compete with natural climate variability."[4] Hansen did, however, suggest that the warming trend in the 1980s was very likely to have been caused by the greenhouse effect. Therefore, his "99%" statement was often confused with the idea that the drought was directly caused by global warming. The latter is obviously absurd, given that the amount of greenhouse gas increase from 1987 to 1988 is very small relative to the major climatic difference between those two years.

The strongest statement one could make responsibly, given the uncertainties, is that increasing the global average temperature could increase evaporation stress, thereby slightly altering the odds toward increased drought. However, as is well known by all atmospheric scientists, droughts are generally a result of unusual patterns of atmospheric circulation, whose causes are not clear cut and most often are ascribed to unusual temperature patterns in the oceans. Later in 1988 that hypothesis of cause and effect would indeed be reaffirmed by calculation made by Kevin Trenberth and colleagues at the

National Center for Atmospheric Research. Unfortunately, many atmospheric scientists were unaware of the exact statements made by Hansen and others who had testified at various hearings during the 1988 summer, and therefore they accepted the widespread perception reported repeatedly in the media that such witnesses believed the greenhouse effect and the drought were cause and effect. This misperception caused an angry and understandable counterreaction. For example, the U.S. National Climate Program office helped to sponsor a workshop on climate trends at the National Academy of Sciences that took place on 29 September 1988. It focused, for example, on a number of difficulties with the observational record used to reconstruct global temperature trends. These include the fact that many thermometers have had cities grow around them which causes an unnatural urban heat island effect. Other errors were noted, such as stations that had moved out to airports or up or down mountains, etc. Shortly I will discuss the seriousness of these issues.

At the same time that this meeting was taking place, the calculations by Trenberth and colleagues were announced. These suggested that unusually cool surface temperatures in the equatorial Pacific (actually, the cool water was flanked by warm water) may have been responsible for distorting the jet stream thereby steering storms up and out of the United States in the spring of 1988 and contributing to the intense drought in the summer. This result was frequently cited in headline after headline to the effect that "Drought of '88 not caused by greenhouse effect after all". Of course, Trenberth never accused any scientists of saying that it was, but the widespread association that was created from the summer's coverage thereby led to a backlash that was, in essence, an artificial debate. For example, in their Science article, Trenberth and colleagues quite rightly argue that "climate simulations indicate that a doubling of carbon dioxide concentrations could increase the frequency of summer droughts over North America. Thus, the greenhouse effect may tilt the balance such that conditions for droughts and heat waves are more likely, but it cannot be blamed for an individual drought."[5] That statement is clearly reasonable and quite consistent with those of Jim Hansen, myself, and most other scientists I am aware of who speak on this issue.

The trial by media of the greenhouse effect was thus a nonscientific issue from the very beginning. Nevertheless, many Op Ed pieces continue to appear from scientists and others criticizing the "hysteria" being generated by some (usually unnamed) public scientists on this issue. For example, S. Fred Singer published a piece in the 30 August 1988 Wall Street Journal entitled, "Fact and Fancy on the Greenhouse Effect", and Woods Hole Oceanographic Institution statistician Andrew Solow had a small piece in the 29 December 1988 International Herald Tribune entitled, "The Greenhouse Effect: Hot Air in Lieu of Evidence." But the most visible recent such article, I believe, was by University of Virginia climatologist Patrick Michaels, whose article "The Greenhouse Climate of Fear" appeared in the Op Ed pages of the Washington Post on 8 January 1989. He lists a number of issues which he believes were improperly or underreported in the press, giving examples of "a few recent revelations that somehow got lost with the ozone". He disparaged Hansen's June testimony forecasting that 1988 would be the warmest year on record, even though recent evidence now suggests that indeed it was.[6] Michaels goes on to refute the greenhouse explanation of drought by citing Trenberth's work to the effect that the drought of 1988 was caused by cold tropical ocean temperatures, something that was never doubted by other scientists. He cites the very recent results of NOAA scientist Tom Karl, who, Michaels says, "arguably knows more about regional climate variation than anyone in the world." Michaels describes

Karl as saying that the NASA-GISS calculations for warming over the United States were too high by nearly 1°F this century because of the urban heat island effect. Because of this, Michaels continues, "there may have been *no* [his italics] global warming to speak of during the last century. Karl's findings surprised none of us who daily toil with the data. But it should be a major shock to those who are using those figures for policy purposes. Is it irresponsible to point this out in public?", Michaels argued.

The results of the Goddard Institute for Space Studies (GISS) and Climatic Research Unit (CRU) are reproduced here as Figure 1. The GISS record shows a warming of about 0.8°C in the past 100 years and the CRU record a global warming of about 0.6°C over the same period. Both include some of the same thermometers, but the CRU record adds an oceanic data set not included in the GISS record. Both groups were aware of and had attempted to account for the artificial heating in urban areas due to the growth of cities around such thermometers during the past century. The question, therefore, is how well were they able to make corrections for this urban effect, and does it indeed, as Michaels implied, invalidate the notion that the globe has been warming for the past century? Neither of these groups had easy access to the vast network of rural stations that Tom Karl at the National Climate Center in Asheville, North Carolina did. Therefore, Karl was able to check the accuracy of predictions of temperature trends in the United States made by both the GISS and CRU groups. What he found was that the GISS results had overestimated the warming trend in the U.S. by a little less than 0.4°C (30% less of an error than Michaels implied), but the East Anglia group had only overestimated it by about 0.15°C Karl found.[7] This GISS global record suggested a warming of about 0.8°C in the past 100 years, and the East Anglia group about 0.6°C or so. Therefore, if one makes the very conservative assumption that the entire world record suffers as strong an urban heat island bias as the United States, and thus applies Tom Karl's corrections to the global record (even though they only apply to the United States), then that correction procedure simply reduces Hansen's record and the CRU record to about 0.5^{o}C ($.9^{o}$F) global warming for the past century. This is not consistent with the frequent statements in the press and on Op Ed pages that urban biases are likely to eliminate the global warming trend over the past century. Moreover, this is not believed by Tom Karl or any other knowledgeable atmospheric scientists I am aware of. Indeed, Andrew Solow has not contested the existence of a global warming trend, only its relevance to the increased greenhouse gas burden of the past 100 years. For example, in an interview with Science magazine's science writer Richard Kerr, Tom Karl commented that "the long-term global warming is something on the order of 0.4^{o}C during the past century. Is the [urban] bias 0.05^{o}C or 0.2^{o}C? The chances that it is the same size as the [global] warming are pretty remote. It is a matter of adjusting the rate of rise, not questioning the rise itself," Karl told Kerr (Science 243, 603, 1989). I know that Tom Karl has been frustrated by the frequently cited implication that he somehow believes otherwise.

Another example of an overblown debate with little relevance to global warming occurred in mid-January when a number of Department of Commerce scientists (including Tom Karl) published a U.S. temperature trend record that got widespread press coverage. They pointed out that there had been no net warming in the United States over the twentieth century. This, too, was greeted with many headlines that the greenhouse effect has not happened in the United States. Good articles (albeit with questionable headlines) appeared on this subject,[8] quoting a number of sources, including the authors of the North American study, to the effect that the United States occupies only a few percent of the world's area, and that there are almost continent-sized regions that have been warming substantially, as well as continent-sized regions that are cooling over the past few decades. Therefore, it is just as foolish to draw global inferences from looking at the small fraction of the Earth represented by the U.S. as it would be to try to predict the outcome of a national election by looking at trends in only one or two states. Nevertheless, an artificial debate has grown over the validity of the greenhouse effect as a result of this publication.

What then, has the debate visible to the public to do with the actual scientific debate? I'm afraid the answer is often "too little". Virtually all atmospheric scientists believe that the greenhouse effect as a scientific proposition is well established and essentially beyond question. Pat Michaels also acknowledges this in his article, as does Fred Singer. The trapping of heat near the Earth's surface from the presence of gases such as water vapor, carbon dioxide, methane, and chlorofluorocarbons has been established from literally millions of measurements over the past century. It is also beyond debate that carbon dioxide has increased about 25% since the industrial revolution, and methane substantially more than that. It is also virtually certain that the CO_2 increases are attributable to human activities, principally, the burning of fossil fuels and deforestation. There is controversy, but it begins to develop over how much trace gases will increase over the next century. Given typical assumptions of growth in fossil fuel use, population, and standards of living into the future, the uncertainties in the greenhouse gas projections are roughly a factor of 3. Uncertainty in the global climate response to a given increase in trace gases is also typically a factor of 2 to 3. Taken together, these uncertainties explain why most national and international assessments suggest that a warming somewhere from as little as one degree to as much as 10^oC (1.8 - 18^oF) is possible by the end of the next century.[8] There are a few who believe that warming could be even more than that or that a cooling could be triggered, but these views represent a very small segment of scientists. Major assessments put the most probable global temperature increase over the next 50 years or so at several degrees Celsius.[9]

Less certain than projections of global average temperature increase is the regional distribution of climate changes. Such changes could have major impact on water resources, agriculture, forests, urban infrastructure, human health, navigation, or coastal planning.[10] Whether predictions of drying in the midcontinental United States and loss of comparative advantage for U.S. agriculture, which are frequently inferred from climatic models, will be true is simply not known now. At the present state-of-the-art, I doubt that reliable forecasts of regional climatic changes will be available much before 20 years. That distant date might be accelerated substantially if both present and expanded research efforts were carefully organized, but even then, we cannot guarantee scientific consensus on the reliability of regional predictions of climate change, even on the time frame of a decade. But I believe it is worth a try to make the effort to improve the reliability of regional climate predictions, for such information would help to put evolving policy making on a firmer factual basis.

Finally, the greatest lack of scientific consensus occurs over whether present uncertainties justify an immediate policy response -- a value judgment, not an issue resolvable by scientific methods. Whether a certain amount of knowledge justifies urgent action or delay depends on whether one fears more investing present resources as a hedge against future change than one fears future change descending without some attempt either to slow it down or make investments to adapt to it more effectively. In my value system, the latter is a clearly preferable course, for I am a believer in insurance against potential catastrophic loss at both personal and national levels. I am frequently disturbed when anyone argues for or against some specific policy action solely on the basis of some supposed scientific knowledge or uncertainty. For example, in his New York Times and International Herald Tribune piece Andrew Solow chides those who "say that if we wait until we are sure about climate change, it will be too late to do anything about it. This argument applies equally to an invasion by aliens from space. More seriously, this argument neglects the costs of overreaction."[11] Of course, what Solow neglects to make explicit is that waiting for more evidence before acting is his value position. He also fails (which is surprising for a statistician) to suggest anything about the different probabilities between an invasion of aliens from space and rapid future climate change. In my estimation, space invaders are no more likely than the collision of the Earth with a very large asteroid -- which would be a catastrophe! The odds of such a collision are presently assessed at something like 1 chance in 10 million each year. But the odds of rapid, potentially unprecedented -- even catastrophic -- climate change are almost certainly in the first decimal place of probability, and I believe the likelihood of several degrees C warming by 50 years is a better than an even bet. In any case, I agree with Solow that the cost of overreaction is a legitimate issue, but so too is the cost of underreaction. The policy process is advanced when scientists provide what they are technically competent to offer: estimates of specific consequences of greenhouse gas buildups and their likelihoods of occurrence -- even if the latter is based on intuitive judgments of technical experts. Any statements beyond that are the personal opinions of those scientists. Although I believe that scientists, like all citizens, are entitled to opinions on how to deal with those probabilities and consequences, we must always be scrupulous to point out that such opinions are personal value judgments.

Finally, the more rapidly climate changes evolve, the more difficult it will be for societies to adapt; and it may be impossible for natural ecosystems to adapt without substantial dislocations or extinctions of some species. The more rapidly greenhouse gases build up, the more difficult it will be for scientists to forecast the outcome reliably. The less we know about the future the less easily we will be able to adapt -- or even take advantage of some of the changes that will occur. Quite simply, the "bottom line" of the evolving greenhouse gas buildup is that we insult the environment at a faster rate than we can predict the consequences, and that under these conditions, surprises are virtually certain.

In order to establish that the greenhouse effect signal has clearly been detected in the climatic record, it is my view that another decade or possibly two will be required to be sure that the warming of the 1980s (which do appear to be the warmest decade recorded on a global basis) will in fact continue into the 1990s and beyond. (I expect it will, but I can't prove it, of course.) If we choose to wait for that added degree of certainty before implementing preventive policies, then this is not a cost-free delay, for it must be done at the price of forcing us and other living things to have to adapt to a much larger dose of change than if we were to act today to slow down the change or to invest affirmatively to make our future adaptations easier. Wrangling over a few tenths of a degree in the historic global temperature trends in this hemisphere or that will not change the fact that postponing action is a basic gamble with our environmental future. Furthermore, the nature of regional climate fluctuations and global trends during the past century are very difficult to establish to a high degree of accuracy because of (a) missing or faulty temperature data as well as (b) incomplete data on other possible competitive causes of climate change, such as changes in the energy output from the sun, human dust, or other pollutants.[12]

Quite simply, the strongest argument for concern about the rapid buildup of greenhouse gases comes not from the small global climatic trends and large regional climatic noise of the recent past, but rather the well-validated nature of the physical processes that have long been understood to accompany increases in infrared radiation-trapping (i.e., greenhouse) gases. Several pieces of strong, but circumstantial, evidence suggest that climate change over the next several decades could proceed at unprecedented rates. But again, this cannot be demonstrated to have occurred on Earth beyond a reasonable doubt without another decade or two of measurement and research. (And, again, waiting before acting is not a risk-free gamble.) Let's consider in more detail this important issue of model validation. Perhaps the most perplexing question about climate models is whether they can ever be trusted enough to provide grounds for altering social policies, such as those governing carbon dioxide emissions. How can models so fraught with uncertainties be verified? There are actually several methods. None of them is sufficient on its own, but together they can provide significant (albeit largely circumstantial) evidence of a model's credibility.

The first method is to check the model's ability to simulate today's climate. The seasonal cycle is one good test because the temperature changes involved are large -- several times larger, on the average, than the change from an ice age to an interglacial period. General-circulation models do remarkably well at mapping the seasonal cycle, which strongly suggests they are on the right track. The seasonal test is encouraging as a validation of "fast physics" such as cloudiness changes. However, it does not indicate how well a model simulates slow processes, such as changes in deep ocean circulation, that may have important long-term effects.

A second method of verification is to isolate individual physical components of the model, such as its parameterizations, and test them against a high resolution sub-model or real data from the field. For example, one can check whether the model's parameterized cloudiness matches the level of cloudiness appropriate to a particular grid box. Or, one can test a GCM grid cloudiness against an isolated mesoscale model. The problem with the former test is that it cannot guarantee that the complex interactions of many individual model components are properly treated. The GCM may be good at predicting average cloudiness but bad at representing cloud feedback. In that case the simulation of the overall climatic response to, say, increased carbon dioxide is likely to be inaccurate.

A third method for determining overall, long-term simulation skill is the model's ability to reproduce the diverse climates of the ancient earth or even of other planets. Paleoclimatic simulations of the Mesozoic Era, glacial/interglacial cycles, or other extreme past climates help in understanding the coevolution of the earth's climate with living things. As verifications of climate models, however, they are also crucial to estimating both climatic and biological future.[13]

Overall validation of climatic models thus depends on constant appraisal and reappraisal of performance in the above categories. Also important are a models' response to such century-long forcings as the 25 percent increase in carbon dioxide and other trace greenhouse gases since the Industrial Revolution. Indeed, most climatic models are sensitive enough to predict warming of at least $1^{o}C$ should have occurred during the past century. The precise "forecast" of the past 100 years also depends upon how the model accounts for such factors as changes in the solar constant or volcanic dust.[14] Indeed, as recent data shows, the typical prediction of a degree C warming is broadly consistent but somewhat larger than observed. Possible explanations for the discrepancy include:[15] (i) the state-of-the-art models are too sensitive to increases in trace greenhouse gases by a rough factor of 2; (ii) modelers have not properly accounted for such competitive external forcings as volcanic dust or changes in solar energy output; (iii) modelers have not accounted for other external forcings such as regional tropospheric aerosols from agricultural, biological, and industrial activity; (iv) modelers have not properly accounted for internal processes that could lead to stochastic or chaotic behavior; (v) modelers have not properly accounted for the large heat capacity of the oceans taking up some of the heating of the greenhouse effect and delaying, but not ultimately reducing, warming of the lower atmosphere; (vi) both present model forecasts and observed climatic trends could be consistent since models are typically run for equivalent doubling of carbon dioxide whereas the world has only experienced a quarter of this increase and nonlinear processes have been properly modeled and produced a sensitivity appropriate for doubling but not for 25% increase; and (vii) the incomplete and inhomogeneous network of thermometers has underestimated actual global warming this century.

Despite this list of excuses why observed global temperature trends in the past century and those anticipated by most GCMs disagree somewhat, the two-fold discrepancy is still encouraging. Most climatologists do not yet proclaim the observed temperature records to have been caused beyond doubt by the greenhouse effect. Thus, a greenhouse effect signal cannot yet be said to be unambiguously detected in the record. It is possible that the observed trend and the predicted warming could still be chance occurrences. One cannot easily rule out that other factors, such as solar constant variations or volcanic dust, simply have not been adequately accounted for over the past century -- except during the past decade when adequate instruments have been measuring them. Nevertheless, this empirical test of model predictions against a century of observations certainly is consistent to a rough factor of 2. This test is reinforced by the good simulation by most climatic models of the seasonal cycle, diverse ancient paleoclimates, hot conditions on Venus, cold conditions on Mars (both well simulated), and the present distribution of climates on earth. When taken together, these verifications provide a strong circumstantial case that the modeling of sensitivity of the global surface air temperature to greenhouse gases is probably valid within roughly two-fold. Another decade or two of observations of trends in earth's climate, of course, should produce signal-to-noise ratios sufficiently obvious that almost all scientists will know whether present estimates of climatic sensitivity to increasing trace gases have been predicted well or not.

Finally, it is my personal belief that we clearly know more than enough to actively pursue those actions which both slow down the rate of buildup of greenhouse gases and at the same time help solve other unrelated societal problems -- what has been called the "tie-in strategy". Delaying rapid change can buy us time to adapt more easily and provide insurance against the not remote possibility of catastrophic rates of change. (Of course, present uncertainties are as likely to cause us to underpredict as to overpredict future changes.) In particular, individuals, firms, and nations should pursue those activities that would make general good sense, regardless of whether the greenhouse effect turns out to be much less serious than presently contemplated. For example, stepped-up investments in energy production and end-use efficiency, accelerated testing of non-fossil fuel alternatives, the development of more widely climate-adapted crop strains, adding flexibility to the management of water systems, and coastal planning to deal with rising sea levels and storm surges all contribute to the solution of existing societal problems even without further climate change. Therefore, it seems prudent, in my value system, to consider implementing first those policies which have multiple benefits, including that of buying insurance against the real possibility of large and potentially catastrophic climate change. I hope that recent shrill or irrelevant debates or headlines do not mask the already large scientific consensus that exists over the basic physical phenomena known as the greenhouse effect, a scientific proposition over which I have heard virtually no scientific dissent.

II. Comments on H.R. 980.

Having responded to the first part of Chairman Hertel's request for me to address the debate in the scientific community and the media over the greenhouse effect and its relation to the summer of 1988, let me turn next to the other request from the Committee, that I comment on the relationship between "policy responses outlined in H.R. 980 in light of the state of our knowledge about global climate change and the relative uncertainties." I was also asked to comment on the measures in H.R. 980 in terms of whether they are "appropriate policy responses to global climate change?". I am happy to do so.

I was indeed gratified at reading the draft language of H.R. 980 and feel that such a measure to coordinate federal activities in global change research and the policy implications of global change is long overdue. I applaud the comprehensiveness of the Act and its recognition of the large and cross-cutting federal role in such research. In particular, the goals of advancing understanding and providing a basis for policy decisions are appropriate in my opinion, but I believe the latter goal may require some further expansion of the already comprehensive nature of this Bill to be even more broad-based so as to maximize the likelihood that this goal can be met. Let me explain. For example, on lines 1-3 of page 6, it is pointed out that "studies to understand the physical, chemical, and biological processes responsible for changes in the Earth system on all time scales" should be included in the Plan. It is my opinion that in addition to these, we must include "the social and political forces driving those changes"; namely, the human, technological, economic, and population changes that will drive trace greenhouse gas increases or land use changes that could impact on biodiversity, for example. This area of knowledge is every bit as important as natural scientific research in helping us to estimate future change. At the same time, if we are to meet the policy objective stated earlier, we will need a Section (E) on page 6 after line 10 to the effect "coordination of studies of the impact of global change scenarios on water resources, agriculture, forests, coastline protection, wetlands, human health, or urban infrastructure." I also believe we may need to add a point (F) with language such as: "initiating policy analyses to help determine the effectiveness of different policy options in adapting to or preventing global changes". I feel that we must distinguish between policy choice, the value-laden activity that is in the responsibility of Congress, and policy analysis, a technical and professional activity that tries to determine the relative efficacy of different policy choices in order to help guide decision-makers in which to choose. The latter clearly needs to be done if the goal of a plan that provides "a basis for policy decisions relating to global change" is to be effectively implemented, as the H.R. 980 language specifies.

In order to enhance the implementation of these additional policy-oriented research activities, I suggest that on page 8, after line 3, the part of H.R. 980 dealing with NSF responsibility, that a phrase be added giving NSF research people the task of "forecasting social behavior that could influence land surface alterations or trace gas emissions." I also suggest adding several additional points to the 4-point list that ends at line 20 on page 8. I would include a point (5), in which the U.S. Department of Agriculture would be mentioned for special responsibility to deal with crop and forest impact assessment and policy analysis, a point (6) in which the Bureau of Reclamation and the Army Corps of Engineers would be given special responsibility for determining water supply implications of various global change scenarios as well as the implications of altered demand due to more efficient water use technology, a point (7) in which the Department of Defense and the State Department would be given special responsibility for assessing the national security implications of global changes that might create migration in Indonesia or Bangladesh; a loss of comparative advantage of U.S. agriculture; or a change in the patterns of sea ice in the Arctic Ocean; and finally, a point (8) might be considered in which the Smithsonian Institution might be given special responsibility to determine the impacts of global changes on biodiversity.

Other than these small points, I strongly approve of the Committee's attempt to raise the priority and coordinate the important but now fragmented efforts across federal agencies in global change research. It is my belief that we cannot make progress on a cross-cutting, interdisciplinary set of problems we have called "global change" unless we also make progress coordinating institutions responsible for the separate components of this research, both in the federal agencies and within the Congressional Committee structure.[16] Disciplinary alignments in universities, agency alignments in the executive branch, and Committee alignments in Congress have been valuable as traditional divisions that allow tractable analyses of important problems. But the era of global change is challenging our conventional notions and requiring us to examine methods for implementing institutional arrangements that insure that cross-cutting questions will not be neglected by the present distribution of "turf" in existing compartments. I applaud the Committee's effort to move this difficult institutional problem forward and to speed the day that we can reliably deal with rapidly evolving problems of global change.

FOOTNOTES

1. For example, see S. H. Schneider and R. Londer, 1984: The Coevolution of Climate and Life (Sierra Club Books, San Francisco), Chapter 8, p. 294-365; or S. H. Schneider, Congressional Testimony before the U.S. House of Representatives Committee on Energy and Commerce, 21 February 1989, Congressional Record (in press); S. H. Schneider, Global Warming: Are We Entering the Greenhouse Century? (Sierra Club Books, San Francisco), to appear summer 1989.

2. J. E. Hansen, 1988: Prepared Statement, The Greenhouse Effect: Impacts on Current Global Temperature and Regional Heat Waves. In Greenhouse Effect and Global Climate Change, Hearing before the Committee on Energy and Natural Resources, U.S. Senate, Washington, DC, June 23, p. 42-79.

3. For example, L. O. Mearns, R. W. Katz, and S. H. Schneider, 1984: Changes in the probabilities of extreme high temperature events with changes in global mean temperature, J. Clim. and Appl. Meteorol. 23, 1601-1613, pointed out that if temperatures were to increase by only 3°F, and nothing else in the climate system changed, then the probability of a heat wave in which five or more days in a row in July saw afternoon temperatures greater than 95°F would increase in Washington, D.C. from a present probability of around 1 in 6 to a future probability of around 1 in 2. In Des Moines, Iowa, the respective probabilities would change from 1 in 18 to 1 in 5. These changes in the odds on "climatic dice" are what would be expected if only temperature increased by 3°F.

4. J. Hansen, letter to New York Times, 11 January 1989.

5. K. E. Trenberth, G. W. Branstator, and P. A. Arkin, 1988: Origins of the 1988 North American Drought, Science 242:1640-1645.

6. For example, in a page 1 story, Philip Shabecoff reports in the February 4, 1989 New York Times that the Climatic Research Unit in East Anglia, England, has concluded that 1988 did, indeed, set a record as the warmest global temperature year. P. D. Jones of that Unit has confirmed by correspondence the accuracy of this story.

7. T. R. Karl and P. D. Jones, 1989: Urban bias in area-averaged surface air temperature trends, Bulletin of the American Meteorological Society 70:265-270.

8. P. Shabecoff, U.S. Data Since 1895 Fail to Show Warming Trend, New York Times, 26 January 1989, p. 1.

9. Please see my recent article, S. H. Schneider, 1989: The Greenhouse Effect: Science and Policy, Science 243:771-781, for references to many such assessments.

10. J. B. Smith and D. Tirpak, Eds., October 1988: The Potential Effects of a Global Climate Change on the United States: Draft Report to Congress, Vols. I and II (Environmental Protection Agency, Washington, DC).

11. A. Solow, Pseudo scientific hot air; the data on climate are inconclusive, New York Times, Vol. 138, p. A-15, 28 December 1988; A. Solow, Greenhouse Effect: Hot Air in Lieu of Evidence, International Herald Tribune, 29 December 1988.

12. See S. H. Schneider, 1989: Science, ibid., pp. 775-776.

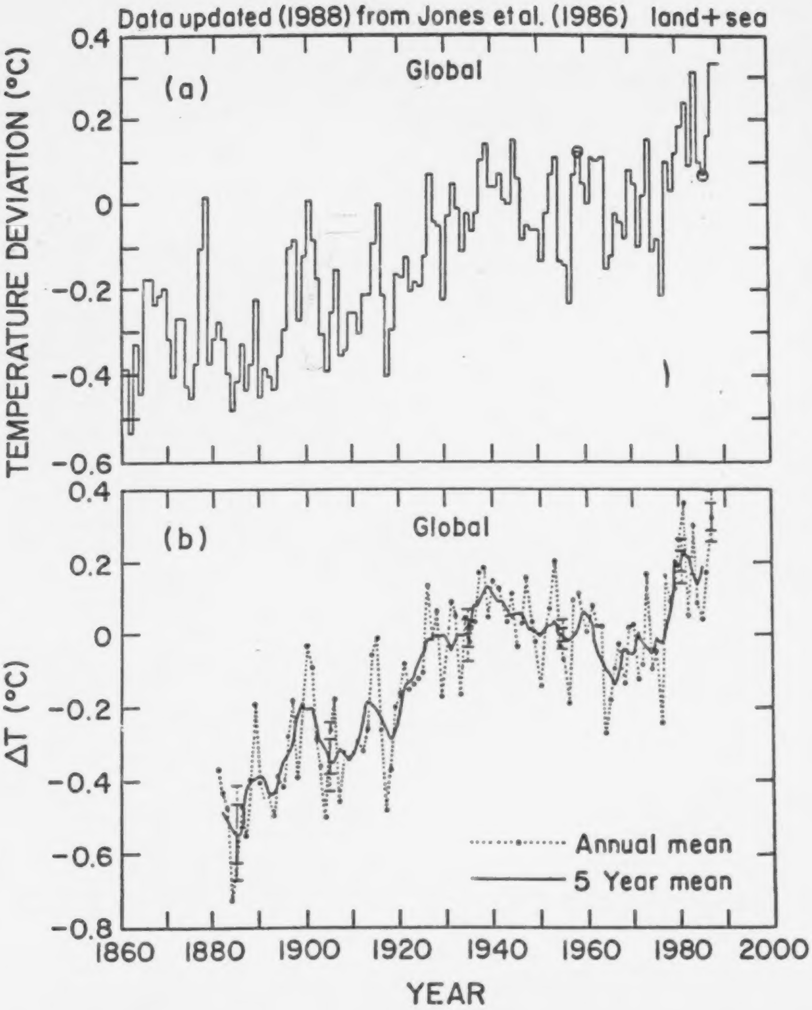
13. S. H. Schneider and R. Londer, 1984: The Coevolution of Climate and Life (Sierra Club Books, San Francisco).

14. S. H. Schneider and C. Mass, 1975: Volcanic dust, sunspots, and temperature trends, Science 190:741-746; R. L. Gilliland and S. H. Schneider, 1984: Volcanic, CO_2, and solar forcing of northern and southern hemisphere surface air temperatures, Nature 310:38-41; J. Hansen, D. Johnson, A. Lacis, S. Lebedeff, P. Lee, D. Rind, and G. Russell, 1981: Climate impact of increasing atmospheric carbon dioxide, Science 213:957-966.

15. S. H. Schneider, 1989: Science, ibid. See especially pp. 775-776.

16. S. H. Schneider, 1988: The Whole Earth Dialogue, Issues in Science and Technology, Vol. IV, No. 3:93-99.

FIGURE 1



A comparison of the global surface temperature trends of the past 100 years constructed from land and island stations and ocean surface temperature data sets at the (a) Climatic Research Unit and from a similar set of stations (minus the ocean surface temperature data set) at the (b) Goddard Institute for Space Studies. [Source: P. D. Jones and T.M.L. Wigley, personal communication (1988); J. Hansen and S. Lebedeff, *Geophys. Res. Lett.* 15, 323 (1988).]

TESTIMONY OF

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BEFORE

THE SUBCOMMITTEE ON OCEANOGRAPHY AND THE GREAT LAKES
ON THE GLOBAL ENVIRONMENT RESEARCH AND POLICY ACT OF 1989
MAY 4, 1989

INTRODUCTION

Thank you for giving me the opportunity to testify before this Subcommittee. My name is Andrew R. Solow and I am a statistician at the Woods Hole Oceanographic Institution. I am a member of the Climate Trends Panel established by the National Climate Program Office (NCPO) and also a member of the scientific working group of the Intergovernmental Panel on Climate Change (IPCC) established by the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO). My work in the area of climate change has focused on the analysis of climate data, with particular attention to the question of detecting the onset of climate change. I have also worked on problems relating to decision-making and the value of information under uncertainty.

The greenhouse effect refers to the process by which trace gases like carbon dioxide trap reflected long-wave solar radiation and warm the atmosphere. This connection between atmospheric composition and climate has been known since the last century. The possibility that human activity could alter atmospheric composition enough to enhance the natural greenhouse effect and cause climate change has been recognized for at least fifty years. The level of carbon dioxide in the atmosphere has increased by about 15% since monitoring began thirty years ago, and by about 25% since the beginning of the Industrial Revolution. This increase appears to be due in large part to human activities like the consumption of fossil fuels and large-

SCALE DEFORESTATION. IN ADDITION TO CARBON DIOXIDE, A NUMBER OF OTHER TRACE GASES -- INCLUDING CHLOROFLUOROCARBONS AND METHANE-- HAVE ALSO BEEN IDENTIFIED AS GREENHOUSE GASES. THEIR LEVELS ALSO APPEAR TO BE RISING. THE CONNECTION BETWEEN ATMOSPHERIC COMPOSITION AND CLIMATE, AND THE DOCUMENTED CHANGES IN ATMOSPHERIC COMPOSITION, HAVE LED TO CONCERN ABOUT THE POSSIBILITY OF SIGNIFICANT GLOBAL WARMING AND ITS POSSIBLE CONSEQUENCES. A REVIEW OF SOME OF THE SCIENTIFIC ISSUES RELATING TO THE GREENHOUSE EFFECT AND ITS ROLE IN CLIMATE CHANGE APPEARED IN A RECENT PAPER BY RAMANATHAN (1).

IT IS CLEAR THAT THE APPROPRIATE HUMAN RESPONSE TO THE POSSIBILITY OF CLIMATE CHANGE DEPENDS ON MANY FACTORS INCLUDING THE TIMING, NATURE, AND MAGNITUDE OF THE CHANGE, AS WELL AS THE BENEFITS AND COSTS OF THE RESPONSE ITSELF. A RESPONSE THAT WOULD BE EFFICIENT UNDER A RAPID CHANGE OF LARGE MAGNITUDE COULD BE A COSTLY MISTAKE UNDER A SLOW CHANGE OF MORE MODEST MAGNITUDE. UNFORTUNATELY, THERE IS A GREAT DEAL OF UNCERTAINTY ABOUT FUTURE CLIMATE. THIS UNCERTAINTY COMPLICATES THE DISCUSSION OF CLIMATE CHANGE IN GENERAL AND THE CHOICE OF POLICY RESPONSE IN PARTICULAR. IT IS ON THIS UNCERTAINTY AND ITS IMPLICATIONS FOR POLICY THAT THIS TESTIMONY WILL FOCUS. I DO WANT TO STRESS AT THE OUTSET THAT THIS DISCUSSION WILL FOCUS EXCLUSIVELY ON ISSUES RELATED TO CLIMATE CHANGE ARISING FROM AN ENHANCED GREENHOUSE EFFECT CAUSED BY HUMAN ACTIVITIES. THUS, I WILL NOT DISCUSS ISSUES RELATING TO THE DEPLETION OF THE OZONE LAYER (ON WHICH I HAVE NOT WORKED) OR ACID RAIN (ON WHICH I HAVE WORKED, BUT ABOUT WHICH I FEEL RATHER DIFFERENTLY THAN I DO ABOUT CLIMATE CHANGE).

CLIMATE MODELS

Much of our information about climate change comes from experiments with large-scale numerical climate models run on computers. The results of these experiments are sometimes treated -- inappropriately, in my opinion -- as forecasts of future climate.

Climate models embody our current understanding of the processes that go into shaping the Earth's climate. These processes include solar activity and the Earth's orbital characteristics; the composition, radiative properties, and circulation of the atmosphere; the chemical, physical, and thermodynamical properties of the oceans; precipitation, streamflow, soil moisture content, evaporation, and cloudiness; the spatial distribution of ice and snow cover and other factors influencing the reflective properties of the Earth; and the behavior of forests, plankton, and other biological populations. There are others. Individually, these processes are complex, with differing temporal and spatial scales of variability. When these processes are coupled together, the complications in the resulting system multiply.

Because our understanding of these processes, the ways in which they interact with each other, and the ways in which they influence, and are influenced by, climate is far from perfect, climate models are far from perfect. In addition, limitations

IMPOSED BY COMPUTING POWER MAKE IT IMPOSSIBLE TO ADEQUATELY COUPLE THE OCEANS AND THE ATMOSPHERE IN THESE MODELS, AND TO ADEQUATELY REPRESENT IMPORTANT, SMALL-SCALE CLIMATE PROCESSES LIKE CLOUDS AND OCEAN EDDIES.

ONE MEASURE OF THE ABILITY OF A CLIMATE MODEL TO FORECAST FUTURE CLIMATE IS ITS ABILITY TO REPRODUCE THE RECENT BEHAVIOR OF CLIMATE. IN PARTICULAR, BECAUSE WE ARE INTERESTED IN FORECASTING CLIMATE SEVERAL DECADES INTO THE FUTURE, IT MAKES SENSE TO ASK HOW WELL THE CLIMATE OVER THE PAST SEVERAL DECADES CAN BE REPRODUCED. THE ANSWER TO THIS QUESTION IS NOT VERY WELL. MOST CLIMATE MODELS "PREDICT" A GLOBAL GREENHOUSE WARMING OF AT LEAST 1°C OVER THE PAST CENTURY. ALTHOUGH THERE APPEARS TO HAVE BEEN SOME WARMING OVER THAT PERIOD, IT HAS BEEN NO MORE THAN 0.5°C AND POSSIBLY MUCH LESS. THIS DISCREPANCY MAY NOT SEEM VERY LARGE, BUT IT IS AN ERROR OF A FACTOR OF AT LEAST TWO. IN ADDITION, THERE IS NO CLEAR EVIDENCE THAT THE RECENT WARMING HAS BEEN DUE TO AN ENHANCED GREENHOUSE EFFECT. IN THAT CASE, NOT ONLY HAVE THE MODELS ERRED IN PREDICTING PAST GREENHOUSE WARMING THAT DID NOT OCCUR, BUT THEY HAVE ERRED IN NOT PREDICTING PAST WARMING THAT DID OCCUR DUE TO OTHER CAUSES. IT IS WORTH POINTING OUT THAT THE ACCURATE REPRODUCTION OF PAST CLIMATE BY A CLIMATE MODEL WOULD NOT GUARANTEE THE ACCURATE FORECASTING OF FUTURE CLIMATE. THIS IS PARTICULARLY TRUE IF THE CLIMATE MODEL IS TUNED -- DIRECTLY OR INDIRECTLY -- BY FORCING IT TO REPRODUCE PAST CLIMATE.

TURNING TO THE PREDICTION OF FUTURE CLIMATE, THERE IS SUBSTANTIAL DISAGREEMENT AMONG CLIMATE MODELS. FOR EXAMPLE, THE

GLOBAL WARMING THAT IS PREDICTED TO ACCOMPANY A DOUBLING OF THE LEVEL OF ATMOSPHERIC CARBON DIOXIDE (THE TIMING OF WHICH IS ALSO UNCERTAIN) RANGES FROM 1.5°C TO 5°C. THE CONSEQUENCES OF A 1.5°C WARMING WOULD BE MUCH DIFFERENT FROM THOSE OF A 5°C WARMING. THE DISAGREEMENT IS WORSE FOR FORECASTS OF REGIONAL CLIMATE. IT IS AGAIN IMPORTANT TO POINT OUT THAT AGREEMENT AMONG CLIMATE MODEL FORECASTS WOULD NOT GUARANTEE THAT THEY ARE CORRECT. THIS IS PARTICULARLY TRUE IF THE CLIMATE MODELS ARE TUNED -- DIRECTLY OR INDIRECTLY -- TO GIVE SIMILAR FORECASTS.

IT IS IMPORTANT TO BEAR IN MIND THAT CLIMATE MODELS WERE NOT INTENDED TO BE USED TO GENERATE FORECASTS OF CLIMATE MANY DECADES INTO THE FUTURE. INSTEAD, THEY WERE INTENDED TO BE USED AS A TOOL FOR LEARNING ABOUT CLIMATE PROCESSES. AS I MENTIONED EARLIER, I WOULD ARGUE THAT THE SCENARIOS GENERATED BY CLIMATE MODELS ARE NOT REALLY FORECASTS AT ALL. IN ANY CASE, IF THEY ARE TREATED AS FORECASTS, THEN IT IS CLEAR THAT THE ASSOCIATED UNCERTAINTY IS VERY GREAT.

FINALLY, IT IS MY IMPRESSION THAT THERE IS LITTLE DISAGREEMENT WITHIN THE CLIMATOLOGICAL COMMUNITY OVER THE SUBSTANCE OF THESE REMARKS -- SEE, FOR EXAMPLE, THE RECENT ARTICLE BY SCHNEIDER (2), ALTHOUGH NOT PERHAPS OVER THE EMPHASIS. MANY CLIMATE MODELLERS WOULD CHOOSE TO STRESS THE SUCCESS OF CLIMATE MODELS AT REPRODUCING CERTAIN ASPECTS OF RECENT CLIMATE AND THE EXTENT TO WHICH MODEL FORECASTS AGREE. WHILE I DO NOT WISH TO MINIMIZE THE SUCCESSES OF CLIMATE MODELS OR THE EXPERTISE AND DEDICATION OF CLIMATE MODELLERS, I DO WANT TO POINT OUT THAT WE ARE STILL VERY FAR FROM HAVING CLIMATE MODELS CAPABLE OF

FORECASTING CLIMATE DECADES INTO THE FUTURE WITH THE KIND OF PRECISION NEEDED TO GUIDE POLICY FORMULATION EXCEPT PERHAPS IN THE CRUDEST SENSE.

CLIMATE DATA

THERE IS A GREAT DEAL OF CLIMATE DATA AND A GREAT DEAL TO SAY ABOUT IT. I WILL RESTRICT MY REMARKS TO A BRIEF DISCUSSION ABOUT LONG-TERM TEMPERATURE DATA AND WHAT THEY TELL US ABOUT THE BEHAVIOR OF GLOBAL CLIMATE OVER THE PAST 100 YEARS OR SO. A MORE COMPREHENSIVE REVIEW OF TEMPERATURE, PRECIPITATION, AND SEA LEVEL DATA IS CONTAINED IN THE FORTHCOMING REPORT OF THE FIRST MEETING OF THE CLIMATE TRENDS PANEL.

ANNUAL TIME SERIES OF INSTRUMENTALLY RECORDED TEMPERATURE ARE AVAILABLE FOR A LARGE NUMBER OF LOCATIONS FOR THE PAST 100 YEARS OR SO. FROM THESE, GLOBAL TEMPERATURE SERIES HAVE BEEN CONSTRUCTED. IN GENERAL TERMS, THESE GLOBAL SERIES SHOW AN IRREGULAR WARMING FROM THE BEGINNING OF THE RECORD IN 1880. THE OVERALL WARMING AMOUNTS TO AROUND 0.5°C OVER THE COURSE OF THE DATA. DURING SOME PERIODS, THE WARMING HAS BEEN RELATIVELY RAPID. THE 1980'S HAS BEEN SUCH A PERIOD, AS WERE THE 1890'S AND THE 1920'S. DURING OTHER PERIODS, LIKE THE 1940'S AND 1950'S, THERE HAS EVEN BEEN SOME COOLING.

THESE DATA ARE NOT WITHOUT PROBLEMS. THESE PROBLEMS INCLUDE INCOMPLETE SPATIAL COVERAGE OF THE MONITORING NETWORK AND CHANGES THROUGH TIME IN THE WAY IN WHICH MEASUREMENTS ARE MADE. ONE IMPORTANT PROBLEM IS THAT MANY OF THE RECORDS CONTAIN A HIGHLY

LOCALIZED WARMING COMPONENT DUE TO POPULATION GROWTH. THIS IS CALLED THE URBAN HEAT ISLAND EFFECT, ALTHOUGH THERE IS SOME EVIDENCE THAT IT IS PRESENT IN TOWNS WITH POPULATIONS AS SMALL AS A FEW THOUSAND. THE URBAN HEAT ISLAND EFFECT MAY ACCOUNT FOR UP TO ONE-THIRD OF THE APPARENT WARMING SINCE 1880.

PERHAPS THE MOST CAREFUL REGIONAL STUDY OF LONG-TERM TEMPERATURE DATA WAS THAT PERFORMED BY HANSON, MAUL, AND KARL (3) FOR THE UNITED STATES. THAT STUDY SHOWED THAT THERE HAS BEEN NO NET WARMING IN THE UNITED STATES OVER THE PAST 100 YEARS. TO MY KNOWLEDGE, THIS RESULT HAS NOT BEEN CHALLENGED IN THE SCIENTIFIC LITERATURE. SOME SCIENTISTS HAVE POINTED OUT QUITE CORRECTLY THAT THE UNITED STATES COVERS ONLY A SMALL FRACTION OF THE EARTH'S SURFACE, AND THAT IT IS DANGEROUS TO DRAW TOO GENERAL A CONCLUSION FROM THESE RESULTS. ON THE OTHER HAND, AS A STATISTICIAN I FIND IT REMARKABLE THAT, IN THE ONLY LARGE AREA FOR WHICH ENOUGH RELIABLE DATA MAY BE IN HAND TO SUPPORT SUCH A CAREFUL STUDY, THERE IS NO EVIDENCE OF LONG-TERM WARMING.

DESPITE THESE RESERVATIONS, MOST CLIMATOLOGISTS BELIEVE THAT THERE HAS BEEN SOME GLOBAL WARMING SINCE 1880. THE QUESTION NATURALLY ARISES AS TO WHETHER THIS WARMING IS RELATED TO AN ENHANCEMENT OF THE GREENHOUSE EFFECT. FOR A NUMBER OF REASONS, THE ANSWER TO THIS QUESTION IS PROBABLY NO. FIRST, THE WARMING BEGAN BEFORE AN ENHANCED GREENHOUSE EFFECT COULD REASONABLY BE EXPECTED TO HAVE BEGUN. IF AN ENHANCED GREENHOUSE EFFECT HAD BEGUN OR INTENSIFIED DURING THE COURSE OF THE DATA, THEN THERE SHOULD BE A SYSTEMATIC ACCELERATION IN THE RATE OF WARMING. NO SUCH ACCELERATION APPEARS IN THE DATA. SECOND, AS I POINTED OUT

EARLIER, THE RATE OF WARMING IS LESS THAN HALF THE RATE EXPECTED UNDER AN ENHANCED GREENHOUSE EFFECT, EVEN IN ITS EARLY STAGES. THIRD, THE SPATIAL DISTRIBUTION OF THE WARMING IS INCONSISTENT WITH THAT EXPECTED UNDER AN ENHANCED GREENHOUSE EFFECT. FOR EXAMPLE, THE UNITED STATES IS EXPECTED TO EXPERIENCE SIGNIFICANT WARMING UNDER AN ENHANCED GREENHOUSE EFFECT. THE RESULTS OF HANSON, MAUL, AND KARL SHOW THAT NO SUCH WARMING HAS OCCURRED. FOURTH, THERE IS AN ALTERNATIVE EXPLANATION FOR THE SLOW APPARENT WARMING OVER THE PAST CENTURY. FROM AROUND 1200 AD TO THE MIDDLE OF THE 19TH CENTURY, THE EARTH EXPERIENCED A COOL PERIOD KNOWN AS THE LITTLE ICE AGE. THERE IS CLEAR EVIDENCE OF THE LITTLE ICE AGE IN MANY LONG-TERM CLIMATOLOGICAL RECORDS. THE SLOW WARMING OVER THE PAST 100 YEARS MAY SIMPLY REPRESENT A RECOVERY FROM SUCH A COOL EVENT.

CLIMATE IS CONSTANTLY CHANGING. WE KNOW THAT CLIMATE CAN CHANGE FOR REASONS OTHER THAN AN ENHANCED GREENHOUSE EFFECT CAUSED BY HUMAN ACTIVITIES. EVEN ASSUMING THAT THE APPARENT SLOW, IRREGULAR WARMING THAT HAS OCCURRED SINCE 1880 IS REAL, THERE IS NO EVIDENCE THAT ANY OF IT IS DUE TO AN ENHANCED GREENHOUSE EFFECT. IN ANY CASE, THE WARMING DURING THE 1980'S IS NOT STRIKINGLY DIFFERENT FROM WARMING THAT OCCURRED EARLIER IN THE RECORD. FROM AN OBJECTIVE POINT OF VIEW, THERE IS NO COMPELLING EVIDENCE THAT AN ENHANCED GREENHOUSE EFFECT HAS BEGUN.

POLICY, UNCERTAINTY, AND INFORMATION

I WOULD LIKE TO MAKE A FEW COMMENTS ABOUT THE PROBLEM OF

MAKING POLICY IN THE FACE OF UNCERTAINTY. THERE IS A BELIEF AMONG CERTAIN SCIENTISTS THAT THE INTRODUCTION OF UNCERTAINTY CHANGES THE PROBLEM OF POLICY-MAKING INTO A PURELY SUBJECTIVE EXERCISE. BY THIS THEY MEAN THAT THERE IS NO NEED TO JUSTIFY THEIR POLICY RECOMMENDATIONS ON ANY OTHER BASIS THAN THEIR PERSONAL FEELINGS. ALTHOUGH THERE IS AN ELEMENT OF SUBJECTIVITY IN ALL POLICY-MAKING (JUST AS THERE IS AN ELEMENT OF UNCERTAINTY IN ALL POLICY-MAKING), THERE IS A WELL-DEVELOPED METHODOLOGY FOR INCORPORATING UNCERTAINTY IN A RATIONAL AND SYSTEMATIC WAY IN THE POLICY-MAKING PROCESS. THE BASIC RESULT OF APPLYING THIS METHODOLOGY IS THAT A BALANCE IS STRUCK BETWEEN POTENTIAL BENEFITS, POTENTIAL COSTS, AND THE PROBABILITIES OF DIFFERENT OUTCOMES.

AS WITH EXPERIMENTS RUN ON CLIMATE MODELS, THE INFORMATION NEEDED FOR A COMPLETE APPLICATION OF THIS METHODOLOGY MAY BE UNAVAILABLE. NEVERTHELESS, AS WITH EXPERIMENTS RUN ON CLIMATE MODELS, THERE IS SOMETHING TO BE GAINED BY EXPERIMENTING ON PAPER WITH THE POLICY PROCESS (FOR EXAMPLE, AS A WAY TO ELIMINATE CLEARLY INAPPROPRIATE POLICIES OR TO IDENTIFY THE INFORMATION NEEDED TO CHOOSE BETWEEN VIABLE POLICIES).

IT IS CERTAINLY POSSIBLE, AND PROBABLY DESIRABLE, TO INCORPORATE A PREFERENCE FOR CAUTION INTO THE POLICY PROCESS. IN GENERAL, HOWEVER, THIS IS NOT THE SAME THING AS ASSUMING THAT THE WORST POSSIBLE SITUATION IS SURE TO OCCUR EVEN IF IT HAS A VERY SMALL PROBABILITY OF OCCURRING. IT IS IMPORTANT TO REALIZE THAT THERE ARE A NUMBER OF POTENTIAL PROBLEMS FACING US WITH CONSEQUENCES AT LEAST AS GREAT AS CLIMATE CHANGE. IN FACING

THESE PROBLEMS, WE DO NOT ACT AS IF THE WORST POSSIBLE SITUATION IS SURE TO OCCUR, NOR SHOULD WE ACT THIS WAY IN FACING THE PROBLEM OF CLIMATE CHANGE.

LARGE-SCALE POLICIES AIMED AT SHARPLY AND RAPIDLY CURTAILING THE HUMAN ACTIVITIES THAT CONTRIBUTE CARBON DIOXIDE TO THE ATMOSPHERE ARE CERTAIN TO BE EXPENSIVE. AFTER ALL, THESE ACTIVITIES ARE NOT PURSUED WITH THE SOLE PURPOSE OF CHANGING ATMOSPHERIC COMPOSITION. ALTHOUGH IT WOULD CERTAINLY BE A MISTAKE TO EXPAND THESE ACTIVITIES RECKLESSLY, GIVEN THE CURRENT UNCERTAINTIES ABOUT CLIMATE CHANGE, I DO NOT BELIEVE THAT SUCH POLICIES ARE JUSTIFIED BY FEARS OF CLIMATE CHANGE ALONE. ON THE OTHER HAND, MORE MODEST POLICIES MAY BE APPROPRIATE, PARTICULARLY IF THEY ARE JUSTIFIED FOR OTHER REASONS AS WELL.

BECAUSE THE ANTIDOTE TO UNCERTAINTY IS INFORMATION, AND BECAUSE INFORMATION TAKES TIME TO GATHER, THE PROPER COURSE OF ACTION IN SOME SITUATIONS IS TO POSTPONE AN ACTIVE POLICY RESPONSE WHILE MORE INFORMATION IS GATHERED. THIS OPTION IS MORE APPEALING THE MORE UNCERTAINTY IS LIKELY TO BE REDUCED BY GATHERING INFORMATION AND THE LESS LIKELY THAT SERIOUS HARM WILL OCCUR AS A RESULT OF POSTPONING AN ACTIVE RESPONSE. IN THE CASE OF CLIMATE CHANGE, I BELIEVE THAT THE VALUE OF INFORMATION IS VERY GREAT, AND THAT POSTPONING AN ACTIVE RESPONSE EVEN BY SEVERAL YEARS IS VERY UNLIKELY TO HAVE A SERIOUS IMPACT ON THE ULTIMATE OUTCOME OF CLIMATE CHANGE. OF COURSE, SOME OF THIS RESEARCH SHOULD FOCUS ON THE DESIGN OF POLICIES THAT COULD BE PUT INTO PLACE FAIRLY RAPIDLY SHOULD FURTHER INFORMATION POINT TO THE LIKELIHOOD OF RAPID, COSTLY CLIMATE CHANGE.

Finally, I would like to point out an example that seems rather relevant to this discussion. In 1980, Schneider and Chen (4) raised the possibility of a 7.6 meter rise in sea level occurring over the next 150 years. They estimated the property loss of the resulting inundation at $1 trillion (in 1980 dollars). By 1989, Schneider (2) stated that a 7.6 meter rise in sea level over the next 150 years "now seems a low probability" and that most workers project an increase of "0.5 to 1.5 meters generally in the next 50 to 100 years". In this case, the passage of time (and further research) may have saved us from a potentially costly policy error.

CONCLUSION

There are legitimate reasons for concern over the possibility of significant and costly climate change. In order to respond effectively to climate change, it is necessary to know rather more than that the possibility exists. Unfortunately, substantial uncertainties exist about the timing, nature, and magnitude of climate change. Climate models provide only a crude representation of climate. They do not perform well at reproducing the recent behavior of climate, nor do their forecasts of future climate agree. Climate data do not provide any compelling evidence of the onset of an enhanced greenhouse effect.

The proper way to account for uncertainty in formulating a policy response is not to act as if the worst possible situation

IS SURE TO HAPPEN. INSTEAD, A BALANCE SHOULD BE STRUCK BETWEEN POTENTIAL BENEFITS, POTENTIAL COSTS, AND THE PROBABILITIES OF DIFFERENT OUTCOMES. GIVEN THE UNCERTAINTIES ABOUT FUTURE CLIMATE, A LARGE-SCALE POLICY RESPONSE IS NOT JUSTIFIED BY FEARS OF CLIMATE CHANGE ALONE. THE BEST WAY TO RESOLVE UNCERTAINTY IS GATHER INFORMATION. WITH REGARD TO THE CLIMATE CHANGE ISSUE, THE VALUE OF INFORMATION IS VERY GREAT AND THE RISKS INVOLVED IN POSTPONING AN ACTIVE POLICY RESPONSE ARE SMALL.

WHILE SOME SEE A DANGER IN EXPRESSING EVEN LEGITIMATE DOUBTS ABOUT THE POSSIBILITY OF CATASTROPHIC CLIMATE CHANGE, THERE IS ALSO A DANGER IN THE WAY IN WHICH THE RECENT DISCUSSION HAS EVOLVED. BY ACTING AS IF CATASTROPHIC CLIMATE CHANGE IS LURKING AROUND THE CORNER, AND BY ASSOCIATING IN THE PUBLIC'S EYE CERTAIN SHORT-TERM METEOROLOGICAL EVENTS WITH LONG-TERM CLIMATE CHANGE, WE RUN THE RISK OF LOSING THE PUBLIC'S ATTENTION AND CONFIDENCE SHOULD DRAMATIC CLIMATE CHANGE NOT BEGIN VERY SOON OR SHOULD OTHER KINDS OF METEOROLOGICAL EVENTS -- LIKE A COOL, RAINY SUMMER -- OCCUR.

THE BILL BEFORE THIS SUBCOMMITTEE (H.R. 980) IS A REASONABLE AND MEASURED RESPONSE TO CURRENT CONCERN OVER THE POSSIBILITY OF CLIMATE CHANGE. BY PROVIDING FOR THE DEVELOPMENT OF A NATIONAL GLOBAL CHANGE RESEARCH PLAN, THIS BILL COORDINATES AND EXPEDITES CONTINUED RESEARCH ON CLIMATE CHANGE AND OTHER GLOBAL ENVIRONMENTAL ISSUES. AS SOMEONE WHO WORKS AT AN OCEANOGRAPHIC INSTITUTION, I AM PARTICULARLY SUPPORTIVE OF THE CLEAR ROLE THAT THIS BILL DELINEATES FOR THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION IN THIS ENDEAVOR. BY ESTABLISHING THE COUNCIL ON

GLOBAL ENVIRONMENTAL POLICY, THIS BILL ENSURES THAT THESE ISSUES RECEIVE THE ATTENTION THAT THEY DESERVE AT A HIGH LEVEL WITHIN THE GOVERNMENT. BY AMENDING THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 TO TAKE INTO ACCOUNT IMPACTS ON THE GLOBAL ENVIRONMENT, THIS BILL RECOGNIZES THE POTENTIAL IMPACTS OF HUMAN ACTIVITIES ON THE GLOBAL ENVIRONMENT, AND PROVIDES A MEANS OF MONITORING AND REGULATING THESE ACTIVITIES.

AGAIN, THANK YOU VERY MUCH FOR GIVING ME THE OPPORTUNITY TO TESTIFY BEFORE THIS SUBCOMMITTEE.

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STATEMENT OF

WILLIAM E. EVANS
UNDER SECRETARY FOR OCEANS AND ATMOSPHERE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON OCEANOGRAPHY AND THE GREAT LAKES
COMMITTEE ON MERCHANT MARINE AND FISHERIES
U.S. HOUSE OF REPRESENTATIVES

MAY 4, 1989

Mr. Chairman and Members of the Committee:

My name is William E. Evans, Under Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. Thank you for the opportunity to discuss NOAA's programs in Global Change and, in particular, the role of the oceans in climate change, and to comment on the Global Environment Research and Policy Act of 1989 (H.R. 980). While we support the purpose of Title I of H.R. 980 we oppose enactment of the bill as unnecessary because it duplicates existing government function and authority.

NOAA's historic monitoring and prediction responsibilities lead naturally into an operational, long-term view of the ocean, one which is critical to the development of a national program in global change research. This is also consistent with NOAA's role as an environmental service, described by Richard Nixon in a Statement to the Congress accompanying Reorganization Plan Number 4 of 1970, which created NOAA:

> "...The oceans and atmosphere are interacting parts of the total environmental system upon which we depend not only for the quality of our lives, but for life itself... We face immediate and compelling needs for a better understanding of the environment - an understanding which will enable us more effectively to monitor and predict its actions, and ultimately, perhaps to exercise some degree of control over them."

NOAA's mission with respect to Global Change has been established within the context of the Committee on Earth Sciences' U.S. Global Change Research Program. The Committee on Earth Sciences (CES) was established in 1987 to coordinate the development and implementation of an integrated Federal research program which would allow the United States to address the issues associated with the global environment. The goal of the resulting U.S. Global Change Research Program is:

> To establish the scientific basis for national and international policy making related to natural and human-induced changes in the global earth system.

To fulfill this goal, Federal agencies will collectively: develop a global monitoring program for earth systems measurements; conduct studies of the physical, chemical and biological processes that influence earth system changes; and develop conceptual and predictive earth system models. NOAA's current role in this Research Program, as endorsed by CES, will include the following: operational in situ and satellite observation and monitoring programs; research on physical and biogeochemical processes in the climate system, including their effects on marine ecosystems and resources; development of models and diagnostic techniques for detecting and predicting natural and human-induced climatic changes; and acquisition and maintenance of long-term data bases and related climate information.

NOAA's Climate and Global Change Program is the Agency's focused contribution to the U.S. Program. It is managed in such a way as to emphasize cooperative efforts throughout NOAA, starting with myself and the Assistant Administrators. The central focus of the Program is NOAA's Office of Global Programs, which is responsible for coordinating the activities. An external panel of science advisors provides scientific input regarding the direction for the program. NOAA actively coordinates with other Federal agencies through CES and the Office of Management and Budget.

The Climate and Global Change Program is focused around four program elements: Long-term Observations, Climate Process Studies, Climate Diagnostics and Prediction, and Climate Data Services. Each of these elements incorporates an oceanic aspect. One of the major areas limiting our ability to ultimately predict global change is our lack of understanding of the role of the ocean in the exchange of heat, water and trace gases with the atmosphere. NOAA's ocean programs are designed to further our capacity to document and predict global change and to project the impacts of this change on our ocean resources. Many of these oceanic programs are part of NOAA's ongoing base activities, but the majority of the proposed new efforts are being advanced as part of the Climate and Global Change Program. For these programs, a NOAA budget request for $20 million is included in the President's FY 1990 Budget.

Now I would like to describe NOAA's research activities related to the role of the oceans in global change.

Ocean Circulation

Given that the upper three meters of the ocean alone can hold as much heat as the entire atmosphere, understanding the role of the ocean clearly is important to understanding climate variability over a number of years. Thus, in order to predict the evolution of climate, we must have in place an integrated observing system to specify the state of the ocean and models capable of assimilating these ocean observations with other Earth system data, to aid in the prediction of the future state of the coupled ocean-atmosphere system. In many ways we are in an analogous situation to that of numerical weather prediction in the 1950's, when computer models and the weather observing network were in their early stages. NOAA maintains operational models and long-term ocean observation systems which are being used in the development of a climate prediction capability.

The rudiments of such an ocean observing system exist now in the tropical Pacific, where a large-scale network for upper ocean thermal structure, sea level and surface winds monitors the evolution of El Nino events. In addition, environmental satellites operated by NOAA play a key role in monitoring global sea surface temperature, cloud cover, solar and longwave radiation, and rainfall over the oceans. We foresee significant expansion of our ocean observing network beyond the tropics as guided by the informational needs of emerging ocean models. These models have demonstrated the ability to assimilate large volumes of ocean data in the most effective manner possible. A full network would also entail maintaining global observations of sea surface temperature, a fundamental air-sea interaction parameter; geochemical tracers, a measure of long-term ocean circulation; and sea ice, a sensitive indicator of climate change and an important factor governing the heat balance of the high latitude ocean-atmosphere system.

Sea level measurements have an important place in the ocean observing system, since the time series of rising sea level is one of the most prominent data sets which have alerted scientists and the public to global change. NOAA will continue installation of a global network to provide accurate measurements of absolute sea level. This baseline will allow the determination of long-term sea level rise without the bias caused by independent land motions. On global scales, NOAA's use of the Navy GEOSAT satellite altimeter has resulted in the operational production of monthly maps of relative sea level over entire ocean basins, and this will be continued under the Climate and Global Change Program.

Predictive modeling of the coupled ocean-atmosphere system clearly requires a better understanding of the way heat and trace gases are exchanged across the ocean-atmosphere boundary. Our knowledge of ocean circulation is far less advanced than our understanding of atmospheric circulation. For this reason NOAA and other Federal agencies support and participate in the World Ocean Circulation Experiment (WOCE), a multi-year international effort to better define the circulation of the global ocean. Research results from the coupled ocean-atmosphere models and the study of past climates suggest that there are certain areas of the ocean such as the North Atlantic, which exert a disproportionate influence over long-term climate change. Focused research in such areas may lead to notable advances in understanding, just as TOGA (Tropical Ocean-Global Atmosphere) investigations in the tropical Pacific have broadened our knowledge of El Nino phenomena.

Biogeochemical Cycling and Climatically Important Gases

Our lack of knowledge of the ocean's physical and biogeochemical control over levels of atmospheric trace gases limits our ability to reliably predict future climate. Preliminary estimates suggest that 40% of the annual release of fossil fuel CO_2 is absorbed by the oceans. Although we recognize that the world's oceans regulate the degree to which CO_2 has increased in the atmosphere, there are no consistent time series measurements of oceanic CO_2 to parallel the atmospheric record.

Only an understanding of the important pathways, fluxes and storage of carbon in the ocean will allow a reliable prediction of the long-term climatic impact of fossil fuel combustion and/or efforts to mitigate the effects of such combustion.

Recent research also has indicated that the ocean may influence climate through the formation of clouds. The major source of cloud condensation nuclei over the ocean is a sulfur compound produced by phytoplankton which forms an aerosol in the atmosphere. Because the reflectance of clouds (and thus the Earth's radiation budget) is sensitive to the density of condensation nuclei, biological regulation of climate is possible through the effects of temperature and sunlight on phytoplankton production of these cloud condensation nuclei.

Climate Change and Fisheries Productivity

In addition to examining the biological influences on climate, we will examine how changes in the ocean environment can affect the living marine resources over which NOAA has stewardship. If there is sea level rise it could have a potentially significant effect on critical fisheries habitats including estuaries and associated wetlands. Relatively modest changes in ocean temperature and circulation could have dramatic effects on the distribution and relative abundance of fisheries stocks. Finally, if there are increases in ultraviolet radiation as a result of ozone depletion, there could be a higher risk of potentially lethal exposure to pelagic fish eggs and to the phytoplankton and bacteria on which the fish feed. Because of these potential consequences, the global fisheries management community will be one of the major users of climate data and information.

Interannual Climate Variability

One of the principal reasons for optimism in the pursuit of long-term climate prediction is the progress which has been made in understanding the role of the equatorial ocean in interannual climate change as a result of the TOGA program. We now have in place an operational ocean model which incorporates data on a regular basis and can simulate many aspects of the evolution of El Nino events. From this work, it was found that the primary weakness in our modeling ability for the tropical surface ocean is the lack of adequate wind information.

TOGA research also has shown that one of the dominant features of the Earth's climate system on interannual time scales is the formation and dissipation of a huge pool of warm water in the western Pacific, a precursor to the El Nino events. A principal focus of TOGA in the early 1990's will be the investigation of the processes by which this pool is formed.

TOGA research has provided insights into climate variability beyond the tropics. Recent findings suggest that the cold water in the equatorial Pacific following the 1987

El Nino played a prominent role in the North American drought of 1988. Diagnostic studies suggest that the ridge of high pressure over the American Midwest was linked by an atmospheric wave train to the tropical Pacific, somewhat like a boulder in a river causing ripples downstream. Unraveling the progression of such climatic events is one of the keys to development of predictive skill.

Oceanic and Atmospheric Modeling

Developing a climate prediction capability will require substantially improving our ability to model the ocean and atmosphere and assimilate data from an ocean monitoring system. NOAA, through the Geophysical Fluid Dynamics Laboratory (GFDL) at Princeton, NJ, and the National Meteorological Center (NMC), pursues a vigorous modeling strategy developing oceanic, atmospheric, and coupled ocean-atmosphere models. I have mentioned examples of the close interaction among ocean monitoring, research, and modeling which NOAA brings to the Climate and Global Change Program. To strengthen the modeling capability, we are requesting funding in FY90 to obtain seventh generation supercomputers for ocean modeling research and other purposes at GFDL and for operational uses at NMC.

Climate Data and Information

NOAA is responsible for the compilation and maintenance of consistent high-quality data bases of marine observations which have been collected across the globe since 1860. Much of our current knowledge about climate change and climate variations has been gleaned from oceanic data. NOAA has taken a first step toward producing a consistent data base of marine observations through development of the Comprehensive Ocean-Atmosphere Data Set (COADS) and will ensure that data from new NOAA observing programs will be consistent with and can be integrated with the historical data base. NOAA is committed to the provision of bias-free data to those in the scientific community involved with the detection of climate change and documentation of the natural variability of climate. We recognize that data and information are the keys to unlocking the global change issue, and we are actively supporting the newly-formed Interagency Working Group on Data Management for Global Change. The goal is a national data and information system for global change research by 1995 that is consistent across agencies, and involves and supports the university and other user communities.

The Global Environment Research and Policy Act of 1989

Finally, I will present, as you requested, our reactions to the Global Environment Research and Policy Act of 1989 (H.R. 980). The Administration opposes H.R. 980 because it duplicates existing government functions and is therefore unnecessary.

While we generally support the concepts of a National global change research plan as described in Title I of the bill, we must point out that the Administration is actively pursuing the implementation of such a government-wide research plan under existing authorities. The Committee on Earth Sciences (CES), established by the Federal Coordinating Council on Science, Engineering, and Technology is responsible for coordinating Federal global change research activities. In January, 1989, the CES published a report entitled: Our Changing Plant: A U.S. Strategy for Global Change Research which accompanied the President's FY 1990 budget submission to Congress. As described in this report, CES is currently preparing a more detailed research plan which will be available for agency use in the spring.

With respect to the Council on Global Environmental Policy which would be established by the provisions of Title II, we defer to the views of the Council on Environmental Quality.

Title III appears to legislate the extraterritorial application of NEPA. We oppose this title as unnecessary because its substance can be implemented under current authority. The Administration currently is reviewing this issue.

Given current Executive Branch activities under existing authorities, the provisions of H.R. 980 would be unnecessary and duplicative. Their enactment could possibly affect our current coordination and planning activities adversely by interrupting the processes already under way. For these reasons we oppose enactment of H.R. 980.

If the Congress should wish to enact the bill despite these concerns on our part, we believe that certain changes would be necessary.

First, the Findings Section should be amended to reflect current scientific uncertainty in our ability to predict global climate change.

Second, we suggest that Section 102(a)(4) should be changed to read as follows: "Development of effective policies to abate and mitigate human-induced global changes and to adjust to both human-induced and natural global changes will depend on our ability to understand global environmental processes, predict global environmental changes, and distinguish between the effects of human activities and the results of natural change".

Third, the proposed new sections 101(b)(4) and 101(c) should be amended to include the Departments of Agriculture and Transportation in the listing of agencies whose programs and activities must be addressed and considered by the Plan. The agencies currently are members of the Committee on Earth Sciences of the FCCSET and are involved with the CES in developing the initial detailed research plan for the U.S. Global Change Research Program.

Finally, proposed Section 101(c) should be amended to reflect the statements of present agency roles which were developed and approved by the CES as part of the initial research plan for the U.S. Global Change Research Plan. Additional agencies which should be included are EPA, USDA, Commerce, Defense, Energy, Interior and Transportation.

In conclusion, we believe that NOAA's ocean programs are part of the foundation for a climate predictive capability, which is one of the principal long-term objectives of the U.S. Global Change Research Program. Through its participation in the interagency Committee on Earth Science, NOAA will continue to participate in the development and implementation of an effective and integrated program to address global environmental change.

STATEMENT OF

DALLAS L. PECK
DIRECTOR, U.S. GEOLOGICAL SURVEY

REPRESENTING

THE COMMITTEE ON EARTH SCIENCES
OF THE FEDERAL COORDINATING COUNCIL
FOR SCIENCE, ENGINEERING AND TECHNOLOGY

BEFORE THE

SUBCOMMITTEE ON OCEANOGRAPHY AND THE GREAT LAKES
OF
HOUSE MERCHANT MARINE AND FISHERIES COMMITTEE
U.S. HOUSE OF REPRESENTATIVES

MAY 4, 1989

Mr. Chairman, I appreciate the opportunity to testify about coordination within the Executive Branch of the U.S. Global Change Research Program and to comment on H.R. 980. I Chair the Committee on Earth Sciences (CES), a Committee of the Federal Coordinating Council on Science, Engineering and Technology, and I will be testifying on behalf of the CES today. Because of the problems I will describe, we cannot support H.R. 980 as currently drafted.

We agree with the concern expressed by the Committee on Merchant Marine and Fisheries over the potential global change of the Earth's environment. Unfortunately, we still do not know the relative contribution of natural processes and human activities to these changes. It now appears clear that human activities may affect the Earth on a global scale. Global change, moreover, involves longer times, larger spatial dimensions, more interdisciplinary emphasis, and a larger number of research agencies and subjects than we have addressed in the past.

The function of the CES is to coordinate planning of earth-science research across the agencies of the Federal Government. Both Presidents Reagan and Bush submitted with their budgets a document entitled "Our Changing Planet: A U.S. Strategy for Global Change Research." This document, prepared by the CES and subsequently referred to as the Strategy Document, presents some of the broad goals, objectives, and concepts in our effort to coordinate global change research. I am submitting a copy of the Strategy Document to your Committee for the record.

In February, Dr. Robert Corell, of the National Science Foundation, testified on behalf of the CES before the Senate Commerce, Science, and Transportation Committee on the subject of global change research and S. 169. I am also submitting for the record a copy of that testimony, which describes some of our scientific understandings about global change and a number of aspects of the research program in some detail, including the content of the Strategy Document.

Scientific Findings

Typical projections for fossil fuel usage imply a doubling of carbon dioxide from pre-industrial levels sometime in the 21st century. Concentrations of carbon dioxide have already been observed to increase by 25 percent over the past century. During this same period the mean annual temperature of the Earth may have increased by about 0.5 degrees Celsius. This statement is somewhat tentative because in many areas of the world the temperature data is spotty. In others it needs to be adjusted for urbanization effects or for changes in the recording stations, which might introduce biases into the record. The science assessment being carried out under the auspices of the Intergovernmental Panel on Climate Change (IPCC) will review this global temperature record and assess what conclusions it will support. A recent study of climate records found no statistically significant evidence of an overall increase in annual temperature or change in annual precipitation for the contiguous U.S., 1895-1987. Because of these uncertainties and other reasons, it is difficult to establish whether the observed global warming of the past century was caused by the observed evidence of carbon dioxide increases in the atmosphere or by other factors. The extent to which there may have been changes in other climatic parameters such as soil moisture and precipitation (which are just as or more important than temperature) is unknown.

The general theory of atmospheric response to change in greenhouse gas concentrations is well recognized. An increase in the amount of greenhouse gases increases the amount of energy trapped by the Earth and consequently raises the Earth's temperature. This in turn affects precipitation, soil moisture, and other climatic measures. Global climate response to changes in carbon dioxide and other greenhouse gases in the atmosphere is not well understood, however. A major problem is that we do not fully understand feedback mechanisms that might either enhance or diminish the effects of greenhouse gas increases, for example, changes in the extent of cloudiness. A slight warming from increased carbon dioxide should increase water vapor in the atmosphere and hence should increase cloudiness, but whether the increased cloudiness will amplify the initial warming or dampen it is not currently known. There are a number of other feedback mechanisms that are likely to be important in the behavior of the total climate system and that are poorly understood.

The geologic record shows that the Earth's climate has varied substantially in the past. During the past 10,000 years there have been intervals when global temperatures were warmer than today by as much as 2 degrees Celsius mean annual temperature and intervals when temperatures have been cooler than present. None of these previous warming events, which lasted up to 1500 years, were caused by human influences on the environment.

The most recent cooling event, called the "Little Ice Age," ended only about 1850 A.D. At least some of the apparent global warming during the last 140 years may be a natural variation, or "recovery" from the Little Ice Age. The future extent of this warming period is not known.

The Research Plan

A Research Plan is being developed; it expands on the strategy document and will be submitted to Congress later this year. The Plan describes the U.S. Global Change Research Program in order to facilitate the planning and coordination of the Federal research and budgetary activities of the Program. It is designed primarily for those who make decisions regarding the conduct and funding of global change research and related activities. The research needs and the priorities respond to the underlying scientific questions, such as (1) what global change has occurred in the past and is occurring now; (2) what physical, biological, geological, and chemical processes are involved in global change; and (3) how well can global change be estimated?

The Research Plan describes the scientific knowledge required to observe, understand, and predict global change and thereby provide the scientific basis for national and international policymaking related to natural and human-induced changes in the global earth system. Overall strategic and research priorities are presented. Strengths of current agency programs, weaknesses, and required research, and FY 1990 agency research initiatives that address those highest priority needs are identified. The section on initiatives is presented by science element, and the role of each of the agencies and their FY 1989 activities is summarized in an appendix.

We are working closely with the Committee on Global Change of the National Academy of Sciences as well as other organizations that represent the scientific community. The Research Plan will assist the coordination of the U.S. Global Change Research Program and the analogous international endeavors, such as the International Geosphere-Biosphere Program and the World Climate Research Program.

Following delineation of the key issues and questions, the Research Plan will show how answers will be provided for policymakers. Drawing on the strengths of our Federal agencies, other national programs and forums, and the international community, a network of cooperation is defined. We then outline what is currently being done to address the key issues and questions and what further needs to be done. Current program descriptions, together with new research efforts or augmentations to existing programs to close the gaps in our knowledge, are presented with budget information. The Research Plan will be updated annually to facilitate an understanding of program accomplishments, needs, and priorities and assist agencies in their formulation of new programs and budgets.

Global Environmental Research and Policy Act of 1989

Although the CES supports the purposes of Title I of H.R. 980, we believe the following changes are essential. Section 101(c) of H.R. 980 allocates global change research responsibilities to four agencies--NOAA, NASA, NSF, and USGS.

Six additional agencies should be included as follows: the Environmental Protection Agency, and the Departments of Agriculture, Defense, Energy, Interior (in lieu of USGS), and Transportation.

The CES has developed a series of statements that define current research responsibilities for the nine agencies referred to above. The Senate Commerce Committee has incorporated most of these changes in S. 169 as reported by the committee on April 18. We believe that either our set of role statements or the ones adopted by the Senate Commerce Committee, slightly modified, should be included in H.R. 980. We will provide copies of these statements for the record if you wish.

Section 103 proposes a process of developing budget coordination within the Executive Branch and between the Executive Branch and the Congress. We believe it is inappropriate to legislate Executive Branch budgeting mechanisms.

Title II of H.R. 980 proposes to establish a Council on Global Environmental Policy and outlines functions already conducted by the Council on Environmental Quality. The establishment of the Council on Global Environmental Policy would be duplicative. The Administration opposes Title III as unnecessary. Its substance, which could be implemented under existing authority, is currently under review.

Given existing activities under current authority, the provisions of H.R. 980 --especially Titles II and III--would be unnecessary, and duplicative, and inappropriate. Because of this we oppose enactment as currently drafted.

This concludes my formal statement. I will be happy to answer your questions.

American Wind Energy Association

June 12, 1989

Honorable Dennis M. Hertel, Chairman
Subcommittee on Oceanography and Great Lakes
House Committee on Merchant Marine and Fisheries
1334 Longworth House Office Building
Washington, D.C. 20515
ATTN: Dr. Thomas R. Kitsos

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A. Norman Terreri
Green Mountain Power Corp.

Environmental Policy Advisor
Christopher Flavin
Worldwatch Institute

H.R. 980, the "Global Environment Research and Policy Act of 1989"

Dear Chairman Hertel:

On April 14, 1989, the American Wind Energy Association wrote to the Committee on Merchant Marine and Fisheries, asking to testify concerning global warming legislation. On May 4, 1989, your Subcommittee conducted hearings on H.R. 980, the "Global Environment Research and Policy Act of 1989," and on May 31, 1989, the Honorable Walter B. Jones, Chairman of the Committee, wrote to AWEA, inviting us to submit testimony for the record on this very important bill.

AWEA and its members appreciate the time and attention your Subcommittee has given to H.R. 980 and other environmental bills, and we truly appreciate the kindness and consideration shown to us by you, by Chairman Jones, and by the capable and cooperative Committee staff. Enclosed please find five (5) copies of AWEA's testimony submitted for the record on H.R. 980.

To summarize our testimony, AWEA offers a discussion of the contributions wind-energy technology is making in the generation of electricity. Today, over 16,000 commercial wind-powered turbines generate electricity in the United States, and increased usage of wind energy and other renewable energy technologies would help achieve the goals of H.R. 980. In short, our testimony illustrates some of the contributions wind energy makes in reducing the emission of CO2, sulfur oxides, nitrogen oxides, and particulates.

Furthermore, AWEA supports most of the provisions of H.R. 980, and our only reservation about the provisions of H.R. 980 is that the 10-year plan for researching the processes and factors which contribute to global environmental change will become a tool which obstructionists will use to delay and/or ultimately defeat the goals of H.R. 980.

Again, we appreciate submitting this testimony for the record, and we hope that AWEA will be permitted to work with you and your Subcommittee as you give additional consideration to environmental problems and the technologies that can help reduce pollution and environmental harms.

Sincerely,

Earl Kelly

Earl Kelly
Director of Government Affairs

1730 N. Lynn Street, Suite 610, Arlington, VA 22209 USA Tel. (703) 276-8334 Telex 6503304640 MCI UW

American Wind Energy Association

Testimony Of

Earl Kelly, Director of Government Affairs

The American Wind Energy Association

Submitted for the Record to the

Subcommittee on Oceanography and the Great Lakes

Of The

House Committee on Merchant Marine and Fisheries

Concerning

H.R. 980, the "Global Environment Research and Policy Act of 1989"

May 4, 1989

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Atlantic Orient Corp.

A. Norman Terreri
Green Mountain Power Corp.

Lawrence E. VanBibber
Westinghouse Electric Corp.

Environmental Policy Advisor
Christopher Flavin
Worldwatch Institute

Mr. Chairman and distinguished Members of the Subcommittee, it is an honor for the American Wind Energy Association (AWEA) to present this testimony for the record concerning H.R. 980, the "Global Environment Research and Policy Act of 1989."

The American Wind Energy Association is a trade association whose members include manufacturers of wind electric turbines and turbine components, consultants specializing in renewable sources of energy, electric utilities, and environmentalists. AWEA was formed in 1974, and develops technical standards for wind-powered electric generating equipment.

On behalf of the members of AWEA, we would like to express our strong support for this Subcommittee's continuing efforts aimed at preserving the environment and reducing the adverse impact of environmental harms that already exist.

The bill being examined by this distinguished Subcommittee, H.R. 980, the "Global Environment Research and Policy Act of 1989," was introduced on February 9, 1989, by ten very prominent Members of Congress who have shown a strong desire to improve our environment, and AWEA's members would like to express their appreciation to these Members of Congress for introducing this bipartisan legislative proposal.

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AWEA would like to undertake three specific goals in this testimony. First, we would like to explain to this distinguished Subcommittee the contributions wind energy and other renewable sources of energy are making toward improving the environment. We feel very strongly that an increased usage of wind energy and other renewable sources of energy, combined with a greater emphasis on conservation and energy efficiency, could greatly improve the environment on a world-wide basis.

Second, we would like to express our support for H.R. 980 and for the reasons stated later in this testimony, we encourage this Subcommittee and the full Congress to work for enactment of the provisions of this important bill.

Finally, we would like to express a major concern about the provisions of H.R. 980, and ask that the Subcommittee work to ensure that the measures contained in this bill do not become self-defeating in the hands of obstructionists who oppose taking action to rectify and/or prevent existing and future environmental harms.

At the outset, AWEA believes that it is important for the Members of Congress and the Administration to recognize the contribution wind energy already is making toward an improved environment.

Wind energy is a clean, cost-effective, renewable means of electricity production. Today, there are over 16,000 commercial wind-powered turbines operating in the United States, and in 1988 they generated over 1.8 billion kilowatt-hours (kWh) of electricity.

These commercial wind-powered turbines are very reliable (over 95% availability), and are already generating electricity at 7-9 cents/kWh, which is cheaper than power from most other renewable energy sources and from many new nuclear plants.

Usable amounts of wind energy exist in nearly all parts of the United States. Estimates show that in the United States wind-powered turbines could supply up to one trillion kWh of electricity per year, an amount equal to about 40% of current national consumption. And, many thousands of wind turbines could be installed at sites in the Great Plains and in the Appalachian Mountain states, helping to diversify our energy supply and preserve air quality.

In addition to being reliable and cost-effective, wind-driven turbines are preventing emission of millions of pounds of sulfur oxides, nitrogen oxides, carbon dioxide, and particulates each year.

Each year, the average-size wind turbine prevents the emission of as much as 200 tons of carbon dioxide (CO2) into the atmosphere, depending on the fuel its output replaces. As we recognize, CO2 emissions contribute greatly to the global warming phenomenon.

In addition to alleviating the emissions that contribute to global warming, each wind-powered turbine prevents the emission of 9,110 pounds of sulfur oxides; 2,803 pounds of nitrogen oxides; and, 175 pounds of particulates each year, if the wind turbine offsets certain types of coal as a source of energy.

If the wind turbine offsets a mixture of oil and gas such as that burned by utility plants in many areas, each commercial turbine (on the average) each year avoids the emission of 595 pounds of sulfur oxides, 368 pounds of nitrogen oxides, and 84 pounds of particulates.

The world market for wind-powered turbines and other renewable energy technologies is growing, and market researchers estimate that by the year 2000 the world market for renewable energy technology will be between $3 billion and $6 billion per year.

AWEA recognizes that wind-powered turbines can help reduce pollution worldwide, since the world market for wind turbines is growing. Developing nations seek to modernize their society and industry, and to utilize electric power sources that do not depend on imported fuel. However, the most reliable machines (over 95% availability) are manufactured in the United States, but American manufacturers have been unable to compete effectively in the export market due to heavily-subsidized machines from other nations.

Furthermore, the United States has reduced its commitment to promoting the use of wind energy, as illustrated by the fact that federal tax incentives, a major source of support for commercial development of wind energy in the United States, were allowed to expire in 1985.

Finally, there has been steady decline in our nation's support for advancements in wind energy, and over the last nine years, federal spending for wind energy research and development (R&D) has been slashed by almost 90%, from $83.7 million in FY 1981 to $8.8 million in FY 1989. The Administration proposes reducing this amount even further, to $8.35 million in FY 1990.

Like wind energy, the provisions of H.R. 980 would help improve the environment substantially.

AWEA supports H.R. 980 in part because this important bill would direct the Federal Coordinating Council on Science, Engineering, and Technology to develop a program that identifies and coordinates the relevant programs and activities of at least eight federal agencies.

Furthermore, H.R. 980 would help coordinate the activities of the Executive Branch and those of the Legislative Branch, and this is a coordination AWEA believes is vitally important. Under the provisions of H.R. 980, the President must identify in each annual budget request submitted to Congress the portion of each agency's annual budget that is allocated to each element of that agency's global change activities.

Additionally, AWEA supports H.R. 980 because it would coordinate the global change research activities of the United States with those of other nations and international agencies and organizations.

AWEA maintains that these three areas of coordination are vitally important, and the new coordination should greatly improve our nation's response to global warming and/or other environmental problems. We seriously doubt that significant progress can be made toward improving the environment until there is better coordination of environmental activities and projects, and H.R. 980 would assist in this important step.

AWEA has one major concern about the provisions of H.R. 980, however. Our main concern arises from the creation of a 10-year program of national research on processes and factors which contribute to global environmental change. We have certain reservations about creation of the 10-year Plan aimed at researching the processes and factors which contribute to global environmental change.

As with any other study, we worry that this study will offer obstructionists in Congress and the Administration an opportunity to delay acting on environmental problems.

Naturally we do not want for Congress to act prematurely on any problem, and at times additional study can help make wise and proper decisions. However, we have had significant experience in working for environmental legislation to know that any study can be turned into a delaying tactic.

Stated briefly, certain leaders had rather "study" a problem than act on it. These leaders maintain that no action on a given issue can be taken until all studies are completed and until the evidence is "conclusive." The result is that they often request additional studies, and, of course, no evidence is ever sufficiently "conclusive" to convince them to take action necessary to remedy the given problem.

AWEA asks the Members of this Subcommittee and the sponsors of H.R. 980 work to ensure that the 10-year study period does not become merely a delaying tactic before our government takes action needed to address environmental problems.

Summary

To summarize our testimony, AWEA maintains that increased usage of wind energy and other renewable energy technologies, along with improved efficiency and conservation, would help achieve the goals of H.R. 980. We have illustrated above some of the contributions wind energy makes in reducing the emission of CO2, sulfur oxides, nitrogen oxides, and particulates.

Furthermore, we strongly support most of the provisions of H.R. 980 and commend this Subcommittee's efforts aimed at improving the environment. Our only reservation about the provisions of H.R. 980 is that the 10-year plan for researching the processes and factors which contribute to global environmental change will become a tool which obstructionists will use to delay and/or ultimately defeat the goals of H.R. 980.

Mr. Chairman and Members of the Subcommittee, AWEA appreciates the opportunity of submitting this testimony for the record, and we will attempt to answer any questions you wish to submit for our response. Furthermore, we hope that each of you will permit AWEA to work with your office in designing ways to reduce our nation's reliance on fossil fuels.

GENERAL COUNSEL OF THE
UNITED STATES DEPARTMENT OF COMMERCE
Washington, D.C. 20230

JUL 18 1989

Honorable Dennis M. Hertel
Chairman, Subcommittee on Oceanography
  and the Great Lakes
Committee on Merchant Marine and Fisheries
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

This responds to your request, presented at a May 4, 1989, Subcommittee hearing, for an explanation of the variance in the views of the Department of Commerce on H.R. 980, the Global Environment Research and Policy Act of 1989, and S. 169, the National Global Change Research Act of 1989.

On February 23, 1989, the Department submitted a report to the Senate Commerce, Science and Transportation Committee expressing support for S. 169, which would add a new title to the National Science and Technology Policy, Organization and Priorities Act of 1976 to place in statute the existing strategy for coordinated Federal global change research. A copy of our report is enclosed.

At the May 4, Subcommittee hearing, the Department expressed support for title I of H.R. 980, which is similar to S. 169, but opposed titles II and III as duplicative of existing government functions. We pointed out the Administration was actively pursuing implementation of a government-wide research plan through the Committee on Earth Sciences of the Federal Coordinating Council on Science, Engineering, and Technology. We deferred to the Council on Environmental Quality with respect to title II, which would establish a Council on Global Environmental Policy. S. 169 does not include provisions similar to title II of H.R. 980.

The Administration also opposed title III, which would extend the application of the National Environmental Policy Act to extraterritorial actions by providing that Federal agencies shall consider the environmental impact of proposed actions on the oceans, atmosphere and other aspects of the global environment. The Department stated the title was unnecessary since such consideration could be carried out under current authority.

S. 169 also does not include provisions similar to title III of H.R. 980. A copy of our testimony on H.R. 980 is enclosed.

We have been advised by the Office of Management and Budget that there is no objection to our submission of this letter to the Congress from the standpoint of the Administration's program.

Sincerely,

Wendell L. Willkie, II
General Counsel

Enclosures

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Secretary
Washington, D.C. 20230

23 FEB 1990

Hon. Ernest F. Hollings
Chairman, Committee on Commerce,
Science and Transportation
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

The Department of Commerce has reviewed S. 169,

"The National Global Change Research Act of 1989,"

and submits the following views on the legislation.

The Department of Commerce supports enactment of S. 169 with the adoption of several minor technical amendments to ensure greater consistency with the existing Federal structure for global change research.

S. 169 would add a new title to the National Science and Technology Policy, Organization and Priorities Act of 1976 (NSTPOP) (42 U.S.C. 6601-6671) to place in statute the existing strategy for coordinated Federal global change research. It would amend NSTPOP to include as one of the principles of a national policy for science and technology the development and implementation of long-range, interagency research plans to support policy decisions.

Proposed new section 601 would set forth the Congress' findings, including a recognition that the development of effective policies to mitigate and cope with human-induced global changes will rely on improved scientific understanding of global environmental processes and the ability to distinguish between the effects of human activities and the results of natural change. The findings also recognize ongoing Federal agency efforts which would contribute to a well-defined and coordinated national program of research, monitoring and assessment.

Proposed new section 602 would require the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) to develop a National Global Change Research Plan (the Plan). The Plan would establish goals and priorities for Federal global change research over a ten-year period as well as set forth the roles and funding levels of each Federal agency in implementing the Plan. Proposed section 602 would require that the Plan address, where appropriate, the relevant programs and activities of the National Science Foundation, the National Aeronautics and Space Administration, the Environmental Protection Agency, and the Departments of Commerce, the Interior, Energy, Agriculture, and Defense. It would establish the Council as the lead entity for overseeing implementation of the Plan, coordinating Federal global change research efforts and reporting at least annually to the President on recommendations for changes in agency roles. The Council also would be responsible for reviewing agency budget requests prior to submission of the President's budget to the Congress and providing the results of the review to the agencies and appropriate elements of the Executive Branch, particularly the Office of Management and Budget (OMB). Further, the Council would coordinate Federal interagency participation in international activities relating to global change research and assessment.

Proposed section 602 also would specify the roles of the Federal agencies currently involved in global change research and require that each agency submit to OMB as part of its annual budget submission a report identifying each element of its proposed global change activities. OMB would be required to review each report and include in the President's budget estimate a breakdown of funding for each agency element. OMB would be required to transmit a copy of the President's annual budget estimate to the chairman of the Council at the time the budget estimate is submitted to the Congress. Finally, new section 604 would require that the Council submit an annual report on global change research efforts to the President and the Congress along with any recommendations for additional action or necessary legislation.

The Department believes S. 169 represents an important step in recognizing recent efforts of the FCCSET to coordinate Federal global change research activities through its Committee on Earth Sciences (CES). The National Oceanic and Atmospheric Administration (NOAA) of the Department has been an active participant in the research effort since the creation of the FCCSET. We recommend, however, the adoption of certain minor technical amendments to reflect current interagency efforts to design and implement the U.S. Global Change Research Program. A description of our recommended amendments is enclosed.

We have been advised by the Office of Management and Budget that submission of this report to the Congress would be consistent with the program of the President.

Sincerely,

Michael A. Levitt

Michael A. Levitt
Acting General Counsel

Enclosure

DEPARTMENT OF COMMERCE
RECOMMENDED TECHNICAL AMENDMENTS TO S. 169, "THE NATIONAL GLOBAL CHANGE RESEARCH ACT OF 1989"

Proposed new sections 602(a)(3) and 602(d)(1) should be amended to include the Departments of State, Agriculture and Transportation in the listing of agencies whose programs and activities must be addressed and considered by the Plan. These agencies currently are members of the Committee on Earth Sciences of the FCCSET and are involved with the CES in developing the initial detailed research plan for the U.S. Global Change Research Program.

Proposed new section 602(d) should be amended to include the statements of agencies' roles which currently are being developed and approved by the CES as part of the initial detailed research plan scheduled for release within the next few months. The statements of agencies' roles are in final draft and CES approval is expected within the next month. We understand CES will provide the Committee with revised language as soon as it is available.

We also recommend deletion of the word "basic" throughout the bill whenever it is used as a modifier of the word "research," particularly in new sections 602(c)(6) and 602(d)(2)(B). "Basic" and "applied" research have specific meanings when applied to the annual reporting of research and development expenditures by agencies to OMB. As described in section 44.3 of OMB Circular A-11 (1988), "basic research" is "systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind." "Applied research" is described as "systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met."

The descriptions result in agencies' reporting much mission-directed research as "applied" research -- including research conducted by NOAA in support of global change. Deletion of the word "basic" throughout the bill would ensure that the legislation would apply to all elements of the U.S. Global Change Research Program, including the work of mission agencies which generally would be considered "applied" research.

○